BT Radioactivity File

Extra Lab Analysis

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January 14, 1983

Mr. Bernard Rains
Metropolitan St. Louis Sewer District
10 East Grand
St. Louis, Mo. 63147

Dear Bernie:

Enclosed is a copy of the news release put out by EPA on the Standards for Remedial Actions at Inactive Uranium Processing Sites along with a copy of the final rule from the January 5, 1983 Federal Register.

Very truly yours,

James K. Grant

James K. Grant
Manager, Environmental Affairs

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enc.

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United States
Environmental Protection
Agency

Office of
Public Affairs (A-107)
Washington DC 20460

EPA Environmental News

FOR RELEASE: WEDNESDAY, DECEMBER 15, 1982

Casey (202) 382-4378

EPA ISSUES
STANDARDS
ON URANIUM
TAILINGS

The U.S. Environmental Protection Agency Administrator Anne M. Gorsuch today announced that the agency has just issued health and environmental protection standards to govern the cleanup and long-term control of tailings generated from uranium ore that was processed during and shortly after World War II.

The Department of Energy and participating states will perform the remedial actions required to achieve these standards, with the concurrence of the Nuclear Regulatory Commission and in consultation with affected Indian tribes and the Department of the Interior.

"We believe that cleanup and long-term control under these standards will virtually eliminate any significant threat to public health and the environment from these tailings," Mrs. Gorsuch said.

Tailings are sand-like natural materials that remain after uranium has been extracted from ore. They contain small concentrations of naturally radioactive materials, such as radium and thorium, which give rise to emissions of radon, a naturally-occurring radioactive gas.

There are about 24 million tons of these tailings distributed on 24 sites covering about 1,000 acres, most of which are in remote areas of the West. A few are at population centers such as Salt Lake City, Utah, Grand Junction, Colo., and Canonsburg, Pa.

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In the past, tailings at many sites have been removed and used in constructing houses, or in other places, as a substitute for sand. Using tailings in construction is especially hazardous, EPA said, because radon decay products accumulate in indoor air. Agency surveys estimate that approximately 6500 different places contain such tailings, and that many hundreds of these are houses or other habitable structures. Tailings have also been blown or washed from most of the piles onto nearby land.

The cleanup standards require that radioactivity in houses where tailings were used, for example in basement foundations, be restored to levels that are more characteristic of background levels of natural radioactivity.

Under EPA's cleanup standard for buildings, the objective is to achieve an indoor radon decay product concentration of 0.02 WL ("Working Level"). Normal air contains redioactivity caused by radon decay. The WL is a measure of the concentration of such radioactivity. Tailings should be removed from premises where the level exceeds 0.03 WL, but lower cost ventilation and air cleaning methods may be used otherwise.

The cleanup standards for contaminated land require surface contamination to be less than 5 picocuries of radium-226 per gram of soil (averaged over the top 15 centimeters) and less than 15 picocuries per gram below the surface. Tailings that have been taken away from the piles for use in non-hazardous locations (such as fence post foundations and small flower beds) would not have to be removed, however.

The control standards require long-term stabilization of the tailings piles to protect against dispersion and misuse, and control of releases of radioactivity to air and water.

The standards require control methods for tailings piles to be effective for at least 200 and, to the extent practicable, for 1,000 years. Radon releases from the piles are limited to less than 20 picocuries per square meter per second. (Current release rates are typically about 10 to 50 times greater.)

The standard does not specify control methods. However, methods are available to satisfy these requirements that will keep tailings from spreading for a very long time, and will discourage access to them.

EPA has decided that general numerical water protection standards are not needed for this remedial action program. Instead, it recommends that any necessary water protection measures be decided site-by-site, based on hydrological and geochemical surveys and relevant state and federal water quality criteria.

The Administrator said, "When the standards have been satisfied, it is very unlikely that the tailings will pose a significant hazard to people during the foreseeable future."

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The Federal Government will pay 90 percent of the remedial action costs and the participating states 10 percent. On Indian reservations, the full cost will be borne by the Federal Government. EPA estimates the cost of meeting the standards will be about $320 million. This would be spread over the seven-year period the law allows for completion of the program.

The standards were developed at the direction of Congress. The Uranium Mill Tailings Radiation Control Act of 1978 (UMTRCA) requires the Federal Government to eliminate or minimize hazards associated with tailings piles left from past uranium milling operations. EPA is responsible for developing standards for these remedial actions.

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R-230

federal register

Wednesday
January 5, 1983

Part II

Environmental Protection Agency

Standards for Remedial Actions at Inactive Uranium Processing Sites

ENVIRONMENTAL PROTECTION AGENCY

40 CFR Part 192

[A-FRL 2211-8a]

Standards for Remedial Actions at Inactive Uranium Processing Sites

AGENCY: U.S. Environmental Protection Agency.

ACTION: Final rule.

SUMMARY: We are issuing final health and environmental standards to govern stabilization, control, and cleanup of residual radioactive materials (primarily mill tailings) at inactive uranium processing sites. These standards were developed pursuant to Section 275 of the Atomic Energy Act (42 U.S.C. 2022), as added by Section 206 of the Uranium Mill Tailings Radiation Control Act of 1978 (Pub. L. 95-604), and were proposed in April 1980 and January 1981.

The standards apply to tailings at locations that qualify for remedial action under Title I of Pub. L. 95-604. The standards for control provide that the tailings be stabilized in a way that gives reasonable assurance that the health hazards associated with the tailings will be controlled and limited for a long period of time. They also establish a requirement to control releases of radon from tailings piles. The standards for cleanup set limits on the radon decay-product concentration and gamma radiation levels in buildings affected by tailings and on the radium-226 concentration in contaminated land.

In response to comments on the proposed standards for disposal and for cleanup, we have evaluated a number of alternatives in terms of their costs and the reductions achievable in potential health effects. A number of changes have been made, including raising some of the numerical limits and eliminating some requirements. The purpose of most of these changes is to make implementation easier and less costly. The changes should not result in any substantial loss of health or environmental protection over that which would have been provided by the proposed standards.

EFFECTIVE DATE: The final standards take effect on March 7, 1983.

ADDRESSES: *Final Environmental Impact Statement.* Background information is given in the *Final Environmental Impact Statement for Remedial Action Standards for Inactive Uranium Processing Sites.* (FEIS), EPA Report 520/4-82-013-1. Single copies of the FEIS, as available, may be obtained from the Program Management Office (ANR-458), Office of Radiation Programs, U.S. Environmental Protection Agency, Washington, D.C. 20460; telephone number 703-557-9351.

Docket. Docket Number A-79-25 contains the rulemaking record. The docket is available for public inspection between 8:00 a.m. and 4:00 p.m., Monday through Friday, at EPA's Central Docket Section (A-130), West Tower Lobby, 401 M Street, S.W., Washington, D.C. 20460. A reasonable fee may be charged for copying.

FOR FURTHER INFORMATION CONTACT: Dr. Stanley Lichtman, Guides and Criteria Branch (ANR-460), Office of Radiation Programs, U.S. Environmental Protection Agency, Washington, D.C. 20460; telephone number 703-557-8927.

SUPPLEMENTARY INFORMATION:

I. Introduction

On November 8, 1978, Congress enacted the Uranium Mill Tailings Radiation Control Act of 1978, Pub. L. 95-604 (henceforth designated "the Act"). In the Act, Congress stated its finding that uranium mill tailings ". . . may pose a potential and significant radiation health hazard to the public, . . . and . . . that every reasonable effort should be made to provide for stabilization, disposal, and control in a safe and environmentally sound manner of such tailings in order to prevent or minimize radon diffusion into the environment and to prevent or minimize other environmental hazards from such tailings." The Administrator of the Environmental Protection Agency (EPA) was directed to set ". . . standards of general application for the protection of the public health, safety, and the environment . . ." to govern this process of stabilization, disposal, and control.

The Act directs the Department of Energy (DOE) to conduct necessary remedial actions at designated inactive uranium processing sites to achieve compliance with the standards established by EPA. Standards are required for two types of remedial actions: control and cleanup. Control is the operation which places the tailings piles in a condition that will minimize the risk to man for a long time. Cleanup is the operation which reduces the potential health consequences of tailings that have been dispersed from tailings piles by natural forces or removed by man and used elsewhere in buildings or land.

In April 1980, we proposed standards for cleanup of tailings (45 FR 27370, April 22, 1980) and made them effective immediately as interim standards (45 FR 27366, April 22, 1980). We took this action to allow DOE to begin remedial work immediately at some contaminated buildings which posed a high level of risk. In January 1981, we proposed standards for control of tailings piles (46 FR 2556, January 9, 1981) and issued a Draft Environmental Impact Statement (DEIS) covering both the control and cleanup standards. Public hearings on the standards were held in Salt Lake City, Utah, on April 24-25, 1981; in Durango, Colorado, on April 27-28, 1981; and in Washington, D.C., on May 14-15, 1981.

We received a wide range of responses to the proposed standards and the DEIS. Sixty-eight substantive comment letters were received and twenty-three individuals testified or submitted comments at the public hearings. Comments were received from a broad spectrum of participants, including private citizens, public interest groups, members of the scientific community, representatives of industry, and State and Federal agencies. We have carefully reviewed and considered these comments in preparing the FEIS and in promulgating these final standards. The written comments are reproduced in the FEIS, which also contains our detailed responses. The major issues raised in public comments, our response to them, and the detailed changes in the standards are given in Sections III and IV. Below we simply summarize the major conclusions reached as a result of our review.

These standards are established to satisfy the purposes of the Act to ". . . stabilize and control . . . tailings in a safe and environmentally sound manner and to minimize or eliminate radiation health hazards to the public." The Act does not provide specific criteria to be used in determining that these purposes have been satisfied. We have therefore made it our objective to establish standards that take account of the tradeoffs between costs and benefits in a way that assures adequate protection of the public health, safety, and the environment; that can be implemented using presently available techniques and measuring instruments; and that are reasonable in terms of overall costs and benefits. We have been especially cognizant of the need to differentiate what would be desirable from what we believe to be necessary to achieve the purposes of the Act.

Substantial dissatisfaction with the proposed standards was expressed in written comments and at the public hearings. In response to these views, we carefully evaluated a number of alternatives with respect to the above factors. Details of each of the alternative control and cleanup standards we considered are given in the FEIS. Selected results of our analysis that are pertinent to our choices for each part of the final standard are given in Section III of this Notice. The following table contains a summary of the alternative standards we considered for control of tailings piles.

ALTERNATIVE STANDARDS FOR CONTROL OF URANIUM MILL TAILINGS PILES

Alternative	Principal requirements		
	Minimum time that controls should prevent erosion and misuse (years)	For radon emission from top of pile (pCi/m²s)	For water quality protection
No standards	None (radioactivity decays to 10 percent in 265,600 yr).	No limit (The average emission is 600 pCi/m²s).	None (Toxic chemicals in tailings at concentrations 100 times background).
EPA proposed standard	1,000	2 above background	No increased concentration of toxic chemicals.
Alternative A	1,000 to 10,000	2 above background	No degradation that would prevent present uses.
Alternative B	200 to 1,000	20	Guidance, based on water quality criteria.
Alternative C	Indefinite, long-term	100	Guidance, based on water quality criteria.
Alternative D	Durable cover; 100-yr institutional control; discourage moving of piles.	No requirement	Prevent significant erosion of tailings to surface water or ground water, or treat water before use.
Alternative E	Minimal cover to prevent wind-blown erosion only; 100- to 200-yr institutional control; move only piles in immediate danger due to floods.	No requirement	No protection required.

The alternative cleanup and control standards can be generally categorized as:

(1) *Least cost* alternatives which provide minimum acceptable health protection, and depend upon the use of institutional methods of control;

(2) *Optimized cost-benefit* alternatives which provide longer term health protection, without reliance on institutional controls, but at somewhat higher costs; and

(3) *Nondegradation* alternatives which attempt to achieve close to the same environmental consequences as might occur if the ore had not been mined; these entail much higher costs, and could result in some undesirable environmental consequences.

Our analysis was based on assuming that remedial actions to satisfy "least cost" tailings pile control standards would entail applying a thin earthen cover and little or no reinforcement of relatively steep side slopes. Integrity of the cover would be assured through active maintenance for 100 years. Only minimal flood protection measures would be applied, and as few as one pile would be moved to a more stable location. Covers would be progressively thicker and less dependent upon care under the more stringent alternatives, with more gradual slopes and greater use of rock for reinforcement. Under the "nondegradation" alternatives, up to half of the piles would be moved to satisfy either water protection or longevity requirements.

The alternative cleanup standards would require progressively more complete removal of tailings from more buildings. Remedial methods that do not involve tailings removal may be used on a limited basis under all but "nondegradation" alternatives.

The more stringent land cleanup alternatives require more complete removal of contaminated material, implying that larger areas may be cleaned up at each contaminated location and somewhat greater numbers of sites qualify for cleanup.

We concluded that the standards we originally proposed approach a "nondegradation" alternative that would, in at least some cases, be difficult to implement, since they specify cleanup and control limits close to background levels. More importantly, the small incremental health benefits, when compared to the benefits for less stringent alternatives, do not appear to justify the large additional costs.

We selected an "optimized cost-benefit" rather than a "least cost" alternative for the final standards, in part because it provides much greater protection of health at only a small increase above the least cost alternatives, and in part because it does not place primary reliance on institutional methods of control. The final standards provide for:

(1) *Control systems for tailings piles*—Control and stabilization which will ensure, to the extent reasonably achievable, an effective life of 1000 years, and in any case, for at least 200 years. This control and stabilization will be designed to provide a barrier which will effectively minimize the potential for misuse and spread of the tailings, limit the average radon emission from the surface of tailings piles to no more than 20 pCi/m²s,[1] protect against flooding, and protect from wind and water erosion. We have also provided an alternative equivalent to the radon emission limit that is stated in terms of the maximum radon concentration in air at locations off the pile.

(2) *Flood control*—Diking or other flood protection controls given first consideration, rather than moving piles, when there is a risk from floods.

(3) *Control of waterborne pollutants*—DOE should assess each site and establish any corrective or preventive programs found necessary to meet relevant State and Federal Water Quality Standards and to be consistent, to the maximum extent practicable, with the Solid Waste Disposal Act, as amended.

(4) *Cleanup of buildings*—An objective for reduction of radon decay products of 0.02 WL,[2] with a maximum limit of 0.03 WL.

(5) *Cleanup of dispersed tailings*—Limitations of soil radium content to 5 pCi/g (above background) averaged over the top 15 centimeters of soil, and to 15 pCi/g averaged over any 15 centimeters of soil below this.

(6) *Cleanup of off-site land*—Remedial actions applied only to situations that constitute a hazard; in those cases, cleanup equivalent to the above standard for dispersed tailings.

The Table below provides a summary comparison of the proposed and final standards. The following sections provide a more detailed discussion of the basis for the final standards.

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[1] A curie is the amount of radioactive material that produces 37 billion nuclear transformations (e.g., decays of radium into radon) per second. A picocurie (pCi) is a trillionth of a curie. One picocurie of material produces just over two transformations per minute. pCi/m²s is a unit for the release rate of radioactivity from a surface (m=meter, s=second). pCi/g is a unit for the radioactivity concentration in a mass of material (g=gram).

[2] A "working level" (WL) is any combination of short-lived radon decay products in one liter of air that will result in the ultimate emission of alpha particles with a total energy of 130 billion electron volts. Working level is a measure of the concentration of radioactivity in the air, not of how much radiation a person actually receives.

SUMMARY COMPARISON OF PROPOSED AND FINAL STANDARDS

	Proposed	Final
Control of Tailings Piles:		
1. Longevity	At least 1000 years	Up to 1000 years, to the extent reasonably achievable, but at least 200 years.
2. Radon emissions from disposal site.	2 pCi/m²s; equivalent to about 99.6% reduction.	20 pCi/m²s, *or* 0.5 pCi/1 in air outside the disposal site; equivalent to about 96% reduction.
3. Water protection	Specific limits for a number of toxic and radioactive contaminants in groundwater; nondegradation of surface water.	Use existing State and Federal standards; apply site-specific measures where needed.
Cleanup of Buildings:		
1. Indoor radon decay products	Shall not exceed 0.015 WL	Shall not exceed 0.03 WL; to the extent practicable, achieve 0.02 WL.
2. Indoor gamma radiation	20 microR/hr	Unchanged.
Cleanup of Land:		
1. Surface	5 pCi/g in any 5 cm layer within one foot of surface.	5 pCi/g in the 15 cm surface layer.
2. Buried	5 pCi/g in any 15 cm layer below one foot.	15 pCi/g in any 15 cm layer below the surface layer.
Exceptions:		
1. Procedure	Site-specific exception procedures	Supplemental standards (may be applied on generic or site-specific basis).
2. Applicability	Where health and safety would be endangered, or where costs clearly outweigh benefits.	Same as proposed; criteria also provided to avoid cleanup of small amounts of tailings and inaccessible tailings posing minimal hazards.

It should be noted that these standards in no way are intended to establish precedents for other situations or regulations involving similar environmental objectives, but with different economic and/or technological circumstances. For example, our forthcoming proposed standards for active uranium mills will be based on an independent analysis of operating and future mills, which may result in different standards. Similarly, our remedial action standard for contaminated buildings should not be taken as an appropriate design goal for indoor radon decay product concentration in new housing, or as a remedial action goal appropriate for all circumstances.

II. Summary of Background Information

Beginning in the 1940's, the U.S. Government purchased uranium for defense purposes. As a result, large quantities of tailings were created by the uranium milling industry. These tailings are a sand-like material, and are attractive for use in construction and soil conditioning. Most of these mills are now inactive, and the ultimate disposal of their tailings has not yet taken place. In addition, tailings have been dispersed from the piles at most of the sites by natural forces, or have been removed by man for use in or around buildings, or on land. The Act provides for the cleanup of these offsite tailings as well as for the long-term control of the tailings piles.

Congress designated twenty-two inactive sites, and the Department of Energy has added two more. The sites are located in the West, predominantly in arid areas, except for a single site at Canonsburg, Pa. Tailings piles at these sites range in area from 5 to 150 acres and in height from a few feet to as much as 230 feet. The amount of tailings at each site ranges from only residual contamination to 2.7 million tons. The twenty-four designated sites combined contain about 26 million tons of tailings covering a total of about 1,000 acres.

The most important hazardous constituent of uranium mill tailings is radium, which is radioactive. We estimate that these tailings contain a total of about 15,000 curies of radium. Radium, in addition to being hazardous itself, produces radon, a radioactive gas whose decay products can cause lung cancer. The amount of radium in tailings, and, therefore, the rate at which radon is produced, will decay to about 10% of the current amount in several hundred thousand years. Other potentially hazardous constituents of tailings include arsenic, molybdenum, selenium, uranium, and, usually in lesser amounts, a variety of other toxic substances. The concentrations of these materials vary from pile to pile.

Radiation and toxic materials may cause a variety of cancers, and other diseases, as well as genetic damage and teratogenic effects. Tailings are hazardous to man because: (1) decay products of radon may be inhaled and increase the risk of lung cancer; (2) individuals may be exposed to gamma radiation from the radioactivity in tailings; and (3) radioactive and toxic materials from tailings may be ingested with food or water. We believe the first of these hazards is clearly the most important.

The radiation hazard from tailings lasts for many hundreds of thousands of years, and some nonradioactive toxic chemicals persist indefinitely. The hazard from uranium tailings therefore must be viewed in two ways. In themselves, the tailings pose a present hazard to human health. Beyond this immediate, but generally limited, health threat, the tailings are vulnerable to human misuse and to dispersal by natural forces for an essentially indefinite period. In the long run, this threat of expanded, indefinite contamination overshadows the present dangers to public health. The Congressional report accompanying the Act expressed the view that the methods used for remedial actions should not be effective for only a short period of time. It stated: "The committee believes that uranium mill tailings should be treated . . . in accordance with the substantial hazard they will present until long after existing institutions can be expected to last in their present forms," and, that "The Committee does not want to visit this problem again with additional aid. The remedial action must be done right the first time." (H.R. Rep. No. 1480, 95th Cong., 2nd Sess., Pt. I, p. 17, and Pt. II, p. 40 (1978).)

For the purpose of establishing standards for the protection of health, we assume a linear, nonthreshold dose-effect relationship as a reasonable basis for estimating risks to the general public from radiation. This means we assume that any radiation dose poses some risk and that the risk of low doses is directly proportional to the risk that has been demonstrated at higher doses. We recognize that the data available preclude neither a threshold for some types of damage below which there are no harmful effects, nor the possibility that low doses of gamma radiation may be less harmful to people than the linear model implies. However, the major radiation hazard from tailings arises from alpha radiation, and the National Academy of Sciences' Advisory Committee on the Biological Effects of Ionizing Radiation (the BEIR Committee) stated in their 1980 report that for ". . . radiation, such as from internally deposited alpha-emitting radionuclides, the application of the linear hypothesis is less likely to lead to overestimates of risk, and may, in fact, lead to underestimates."

Our quantitative estimates of radiation risk are based on our review of epidemiological studies, conducted in the United States and in other countries, of underground miners of uranium and other metals who have been exposed to radon decay products, and on three reports: *The Effects on Populations of Exposure to Low Levels of Ionizing Radiation* (1972) and *Health Effects of Alpha Emitting Particles in the Respiratory Tract* (1976) by the BEIR Committee, and the report of the United Nations Scientific Committee on the Effects of Atomic Radiation entitled *Sources and Effects of Ionizing Radiation* (1977). Details of our risk estimates are provided in *Indoor Radiation Exposure Due to Radium-226 in Florida Phosphate Lands* (EPA 520/4-78-013) and in the FEIS.

Although the studies of underground miners show that there is a significant risk of lung cancer from exposure to radon decay products, there is some uncertainty about its magnitude. Exposures of miners are estimated from the time spent in each location in a mine and the measured radon decay product levels at those locations. However, radon decay product measurements were infrequent and often nonexistent for exposures of miners prior to the 1960's. The uncertainty increases when data for miners are used to estimate risk to the general population because there are differences in age, physiology, exposure conditions, and other factors between the two populations. Nevertheless, we believe the information available provides an estimate of risk which is probably reliable within a factor of two or three, and that this constitutes an adequate basis for these standards.

It is not possible to reduce the risk to zero for people exposed to radiation or, for that matter, to many other hazardous materials. In order to decide on an appropriate level of a small residual risk, we evaluated the costs and benefits of different levels of control. We also considered technical difficulties associated with implementing different levels of control.

The legislative record shows that Congress intended that EPA set general standards and not specify any particular method of control. Therefore, our analyses of control methods, costs, risks, and other pertinent factors emphasize the general characteristics of uranium mill tailings and the designated sites. The Act gives other agencies of the Federal Government the responsibility to decide how to satisfy these standards at specific sites. They will issue site-specific Environmental Impact Statements or Environmental Assessments, as appropriate, covering such matters.

The information upon which we based these health and environmental standards for control and cleanup of tailings from inactive uranium processing sites is summarized below. Additional background information and more complete presentations are given in our notices of proposed rulemaking (45 FR 27370, April 22, 1980, and 46 FR 2556, January 9, 1981) and in the FEIS.

A. The Risks from Tailings

Uranium mill tailings can affect man through four principal environmental pathways:

- *Diffusion of radon-222, the decay product of radium-226, from tailings into indoor air.* Breathing radon-222, an inert gas, and its short half-life decay products, which attach to tiny dust particles, exposes the lungs to alpha radiation (principally from polonium-218 and polonium-214). The exposures involved may be large for persons who have tailings in or around their houses, or who live very close to tailings piles. Additional, but smaller, exposures to alpha radiation may result from long-lived radon-222 decay products (principally lead-210 and polonium-210). Exposure due to radon from tailings in or around buildings is best estimated from direct measurements of its decay products in indoor air.
- *Direct exposure to gamma radiation.* Many of the radioactive decay products in tailings produce gamma radiation. The most important are lead-214, bismuth-214, and thallium-210. Hazards from gamma radiation are limited to persons in the immediate vicinity of piles or removed tailings. Exposure due to gamma radiation from tailings is readily estimated from direct measurements.
- *Dispersal of small particles of tailings material in the air.* Wind erosion of unstabilized tailings piles creates airborne tailings material. The predominant dose is to the bones from eating foods contaminated by thorium-230, radium-226, and lead-210, and is small. Exposure due to airborne transport of radon and particulates from a pile usually cannot be directly measured, but may be estimated using meteorological transport models.
- *Waterborne transport of radioactive and toxic material.* Dispersal of unstabilized tailings by wind or water, or leaching, can carry radioactive and other toxic materials to surface or ground water. Current levels of contamination appear to be low or nonexistent. However, some long-term future contamination of surface and ground water and consequent intake by man and animals is possible. Potential exposures due to the transport of waterborne contaminants are highly site-specific and can generally only be determined by a careful survey program.

The following discussion of risks focuses largely on current biological effects; however, these current effects could be expanded by future misuse of tailings by man and by uncontrolled effects of natural forces. Our standards reflect consideration of both current and future impacts of tailings.

1. Air Pathways. We estimated the hazards posed by radon emissions to air from uranium mill tailings piles and from tailings used in and around houses. For the first case we used meteorological models and considered people in the neighborhood of the pile, the population in the local region, and the remainder of the national population. For the second, we drew largely upon experience from contaminated houses in Grand Junction, Colorado. Four sources of exposure were considered: inhaled short-lived radon decay products, gamma radiation, the long-lived radon decay products, and airborne tailings.

From our analysis we conclude:

(a) Lung cancer caused by the short-lived decay products of radon is the dominant radiation hazard from tailings. Effects of gamma radiation, of long-lived radon decay products, and of airborne tailings from the piles are generally much less significant, although high gamma radiation doses may sometimes occur.

(b) Individuals who have tailings in or around their houses often have large exposures to indoor radon and hence high risks of lung cancer. For example, in 50% of a sample of 190 houses with tailings in Grand Junction, Colorado, we estimate that the lifetime excess risk due to exposure to short-lived radon decay products prior to remediation may have been greater than 4 chances in 100.

(c) Individuals living near an uncontrolled tailings pile are also subjected to high risks from short-lived radon decay products. For example, we estimate that people living continuously next to some of the piles may have lifetime excess lung cancer risks as high as 4 chances in 100.

(d) Based on models for the cumulative risk to all exposed populations, we estimate that, without remedial action, the radon from all the inactive sites considered together could cause about 170 to 240 potential excess lung cancer deaths per century. Of these, 55% to 80% are projected to occur among persons living less than 50 miles from a pile.

There is a substantial uncertainty in these estimates because of uncertainties in the rate of release of radon from tailings piles, the exposure people will receive from its decay products, and

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from our incomplete knowledge of the effects on people of these exposures. In addition, our estimates are based upon current sizes and geographical distributions of populations. If populations increase in the future, the estimated impact would be larger.

We concluded that a primary objective of standards for *cleanup* of tailings should be to remove or reduce existing and potential risks due to radon decay products indoors. Such risks from indoor radon decay products arise in two ways—in existing buildings where tailings were used in construction and cause elevated levels, and from land contaminated sufficiently to cause elevated levels in new construction. A secondary objective should be to reduce high exposures to gamma radiation due to tailings in buildings or on land away from the tailings piles.

We concluded that a primary objective of standards for *control* of tailings should be isolation and stabilization to prevent their misuse by man and dispersal by natural forces, such as wind, rain, and flood waters. A second objective should be to reduce radon emissions from tailings piles. A third objective should be the elimination of significant exposure to gamma radiation from tailings piles.

2. Water Pathways. Although water contamination does not now appear to be a significant source of immediate radiation exposure at the piles, both radionuclides and nonradioactive toxic substances, such as arsenic, molybdenum, and selenium, could be leached or otherwise removed from tailings and contaminate water resources. If this occurred, it could then affect crops, animals, and people. Such contamination could, in principle, be caused by either past or future releases from the tailings. Tailings piles at inactive sites have already lost most of the water deposited in them during mill operations through evaporation and seepage. However, elevated concentrations of radioactive or toxic substances in ground water have been observed at only a few of the designated sites (four are identified in the FEIS), and in some standing water ponds (but not in running water). Any future water contamination would arise from the effects of rain or through flooding of a pile, from penetration of a pile from below by ground water, or from leaching of tailings transported off a pile.

A theoretical analysis performed for the Nuclear Regulatory Commission (NRC) of a larger model pile showed that contamination of ground water by selenium, sulfate, manganese, and iron might exceed current drinking water standards over an area 2 kilometers wide and 8 to 30 kilometers long. However, more than 95% of this projected contamination was attributable to initial seepage of process water discharged to the pile during mill operations. The movement of contaminants through a pile and subsoil to ground water depends on a combination of complex chemical and physical properties, as well as on local precipitation and evaporation rates. Chemical and physical processes can effectively remove or retard the flow of many toxic substances passing through subsoil. However, some contaminants such as arsenic, molybdenum, and selenium, can occur in forms that are not removed. Typically, ground water can move as slowly as a few feet per year, and only in coarse or cracked materials does the speed exceed one mile per year. For these reasons, contaminants from tailings may not affect the quality of nearby water supply wells for decades or longer after they are released. However, once contaminated, the quality of water supplies cannot usually be easily restored simply by eliminating the source (although, in some cases removing or isolating the tailings may contribute to improving water quality).

Based on results from the NRC generic model for mill tailings piles, it is likely that the few observed cases of ground water contamination resulted from seepage of the original liquid waste discharges from the mill. Additional future contamination of ground water should be much smaller, and in most cases would be expected to be minimized by measures required to control misuse of tailings by man and dispersal by wind, rain, and flood waters. These measures should also effectively eliminate the threat of contamination of surface water by runoff or from leaching of tailings transported off piles, and provide reasonable protection of surface and ground water from contamination by flooding. However, at a few specific sites, especially in areas of high rainfall or where ground water tables intersect the piles, special consideration of possible future contamination of ground water may be needed.

Though a few sites appear to have some existing contamination due to the presence of tailings, we believe it will usually not be feasible or practical to remove the contaminants from subsoil or ground water. Whether or not it is feasible or practical to restore an aquifer and to what degree will depend on site-specific factors, such as the ability to restore the aquifer in its hydrogeologic setting, the cost, the present and future value of the aquifer as a water resource, the availability of alternative supplies, and the degree to which human exposure is likely to occur.

We concluded that potential contamination of surface and ground water at the inactive sites must be considered on a site-specific basis. The remedial program should provide for adequate hydrological and geochemical surveys of each site as a basis for determining whether specific water protection or cleanup measures should be applied. In many cases, the control measures needed for other purposes should reduce any potential for contamination.

In addition to the available information upon which we based our conclusion, hydrological and geochemical studies are presently being conducted or planned at a number of sites. The purpose of these studies is to gather additional information so as to more fully assess any actual or potential ground water contamination and to better understand the mechanism of contaminant movement. The studies will identify the extent and character of contaminants remaining in the piles, as well as the direction, rate of movement and degree of attenuation of any contaminants already released. In particular, attention is being given to identifying the likelihood of contaminants reaching an actual or potential water supply source. We are currently reviewing current studies and will review future studies assessing the site-specific factors related to potential ground water contamination.

As stated previously in this Section II, site-specific Environmental Assessments (EAs) or Environmental Impact Analyses (EIAs) will be prepared for each site. We will review the information generated as part of those. The EAs or EIAs would gather data on a site-specific basis which would either characterize the site completely or confirm the use of general models in determining potential mechanisms for impact or lack of impact on ground water.

We believe that it is important to conclude these studies as quickly as possible. These studies will provide a more complete data and analytical base to allow us to reevaluate the decision not to set ground water protection standards. Information to be obtained as a part of the studies will include the response of the tailings and interstitial fluids to water table and precipitation stimuli; distribution of radionuclides and other contaminants within the tailings pile; identification of mobile constituents within the tailings and ground water system; and analyses of the mechanisms for the release and transport of the contaminants both to the surface and downward to ground water.

To date, the results of more recent studies than those we described in our FEIS strongly support our decision not to issue general numerical water protection standards. We intend to continue to review additional information as it becomes available, and will reconsider our decision if the need to do so becomes apparent.

B. Cleanup and Control of Tailings

1. Control of Tailings Piles. The objectives of tailings control and stabilization efforts are to prevent their misuse by man, to reduce radon emissions (and gamma radiation exposure), and to avoid the contamination of land and water by preventing erosion by natural processes. The longevity (i.e., long-term integrity) of control is particularly important. This is affected by the potential for disruption by man; by the probability of occurrence of such natural phenomena as earthquakes, floods, windstorms, and glaciers; and by chemical and mechanical processes in the piles. Prediction of the long-term integrity of control methods becomes less certain as the period of concern increases. Beyond several thousand years, long-term geological processes and climatic change become the dominant factors.

Methods to prevent misuse by man and disruption by natural phenomena may be divided into those whose integrity depends upon man and his institutions ("active" controls) and those that do not ("passive" controls). Examples of active controls are fences, warning signs, restrictions on land use, and inspection and repair of semi-permanent tailings covers, temporary dikes, and drainage courses. Examples of passive controls are thick earthen covers, rock covers, massive earth and rock dikes, burial below grade, and moving piles out of locations highly subject to erosion, such as unstable river banks.

Erosion of tailings by wind, rain, and flooding can be inhibited by contouring the pile and its cover, by stabilizing the surface (with rock, for example) to make it resistant to erosion, and by constructing dikes. If necessary, erosion can be inhibited by burying tailings in a shallow pit or moving them away from a particularly flood-prone or otherwise geologically unstable site.

Methods to control release of radon range from applying a simple barrier (such as an earthen cover) to such ambitious treatments as embedding tailings in cement or processing them to remove radium, the precursor of radon. Covering tailings with a permeable (porous) barrier, such as earth, delays radon diffusion so that most of it decays and is effectively retained in the cover. In addition to simple earthen covers, other less permeable materials such as asphalt, clay, or soil cement, usually in combination with earthen covers, may be used. The more permeable the covering material, the thicker it must be to achieve a given reduction in radon release. However, maintaining the integrity of very thin impermeable covers, such as plastic sheets, even over a period as short as several decades is unlikely given the chemical and physical stresses present at piles.

The most likely constituents of covers for use to control tailings are locally available earthen materials. The effectiveness of an earthen cover as a barrier to radon depends most strongly on its moisture content. Typical clay soils in the uranium milling regions of the west exhibit ambient moisture contents of 9% to 12%. For nonclay soils ambient moisture contents range from 6% to 10%. The following table provides, as an example, the cover thicknesses that would be required to reduce the radon emission to 20 pCi/m^{2}s for the above ranges of soil moisture. Three examples of tailings are shown that cover the probable extreme values of radon emission from bare tailings at the designated sites (100 to 1000 pCi/m^{2}s); the most common value is probably somewhat less than 500 pCi/m^{2}s.

ESTIMATED COVER THICKNESS (METERS) TO ACHIEVE 20 PCI/M^{2}S

Radon emission from tailings (pCi/m^{2}s	Percent moisture content of cover			
	6	8	10	12
100	1.7	1.3	1.0	0.7
500	3.4	2.6	2.0	1.5
1,000	4.1	3.2	2.4	1.8

These values are for simple homogeneous covers. In practice, multi-layer covers using clay next to the tailings can be used to significantly reduce the total thickness required.

Methods that control radon emissions will also prevent transport of particulates from the tailings pile to air or to surface water.[3] Similarly, permeable covers sufficiently thick for effective radon control will also absorb gamma radiation effectively (although thin impermeable covers will not).

[3] However, recent studies suggest the possibility that some chemical processes in tailings piles could carry dissolved contaminants upward, perhaps even through earthen coverings. Control system designers must carefully consider this possibility.

Control of possible contamination of ground water is difficult. In the few cases where this is a potentially significant problem, clay liners and/or clay caps may provide a good degree of protection for at least many decades. However, more permanent protection may require removal to a site with more favorable hydrological, geochemical, or meteorological characteristics.

Very effective long-term inhibition of misuse by man, as well as of releases to air and surface water, could be achieved by burying tailings in deep mined cavities. In this case, however, direct contact with ground water would be difficult to avoid. The potential hazards of tailings could also be reduced by chemically processing them to remove contaminants. Such processes have limited efficiencies, however, so the residual tailings would still require control. Furthermore, the extracted substances (e.g., radium and thorium) would be concentrated, and would require further control.

We analyzed the costs of a number of possible control methods. The total cost is affected most strongly by the type of material used to stabilize the surface against erosion and inhibit misuse by man, by the water protection features required, and by the number of piles that must be moved to new sites. In general, costs of covers using man-made materials (e.g., asphalt) are somewhat higher than costs for earthern covers. Active control measures are usually less costly in the short term than are passive measures. The costs for burial of tailings piles or for using chemical processing to extract radium (and perhaps other substances) are much higher than those for disposal using covers. We find that, given a decision to carry out any significant stabilization, the total cost of control using earthen covers does not depend strongly on the degree of reduction of radon emissions, for reductions by up to about a factor of 50 (the maximum that would probably be required at any site under these standards).

2. Cleanup of Tailings. The objective of cleanup of tailings from buildings is to reduce elevated indoor levels of radon decay products and gamma radiation. The objective of cleanup of tailings from land is to remove the potential for elevated levels of radon decay products in future buildings, and exposure of people to gamma radiation.

A variety of methods for cleanup of buildings are available. The most commonly used, and the most reliable and permanent measure, is to dig out the tailings and return them to the pile. This is sometimes relatively easy, such as removing tailings from outside footings, but may be very difficult, as in removing tailings from under a concrete slab floor in a finished room. Other methods include air filtration, improved ventilation, and the use of sealants to keep out radon.

Windblown tailings on lands around a tailings pile are usually removed by scraping off the top few inches of earth with earth-moving equipment and adding it to the pile. Land cleaned up in this way is relatively easily restored to close to background levels of radioactivity because windblown tailings are usually on the surface and easy to remove. Generally the cost is determined by the amount of land scraped, and not by the depth of scraping required. Alternatively, the land could be removed from productive use, access restricted, and the tailings fixed on the site by deep plowing.

When tailings have been removed from piles and misused in other ways, such as for soil conditioners in gardens and yards or as fill under detached buildings, the usual cleanup measure is to dig up the tailings and return them to the pile.

III. Resolution of Major Issues Raised in Public Comments

A. The Basis for the Standards

1. Health Risk Models. Some commenters considered that the models we used to estimate risks from breathing radon decay products underestimate the risk. More, however, argued that the models overestimate the risk. Some of these comments argued that the use of data on exposure of underground miners was not valid for estimating risks to the general public and suggested that we should use a lower risk estimate recently published as a contributed article in *Nature* (*290*:98, 1981).

We have reviewed the evidence presented and conclude that it does not support changing the risk models we have used. We agree that some evidence exists that risks may be either higher or lower than those we use, but, when all the available information is carefully considered, this evidence is not compelling. It is also true that the use of data on underground miners to predict risks to the general public is less than ideal; however, we have corrected for the most obvious difference (breathing rate) and do not believe this substantial body of evidence can be ignored. Finally, the estimates published in the article in *Nature* are not convincing. The upper limit of lung cancer risk given by these authors is apparently based on assuming that the total period of risk following exposure is only 15 years. However, the evidence from the Japanese A-bomb survivor data, the only large body of data for a general population, leads to use of a lifetime period of risk following exposure. Our detailed responses to these comments are presented in the FEIS.

2. Cost Estimates. Commenters suggested that our estimates of the costs to implement the standards were low (by a factor of two or more) and that we had not included costs for engineering, field supervision, contingencies, or for reclamation of borrow pits from which cover material was obtained.

Many of these comments are correct. Our estimates in the DEIS were expressed in 1978 dollars. Costs of some construction activities have increased substantially between 1978 and 1982. We have revised our cost estimates to reflect these changes, and have also included previously omitted costs for engineering, field supervision, contingencies, and reclamation of borrow pits. We have analyzed specific estimates of the cost of meeting the proposed standards and find that our revised estimates are lower than those of the DOE, but in substantial agreement with those provided by industry and NRC. Our cost estimates are reported in detail in the FEIS.

3. Cost-Benefit Analysis. Commenters expressed the view that the cost of implementing the proposed standards will be high compared to the benefits, that we failed to carry out a cost-benefit analysis for these standards, or that we did not adequately consider alternatives to the standards proposed.

It is not possible to carry out a formal quantitative cost-benefit analysis for these standards. Many of the hazards reduced (or avoided) through their application (or through application of alternative standards) can neither be evaluated quantitatively nor restated in terms of a common index of value. The major hazard, the extent of possible future misuse of tailings by man, is almost impossible to quantify. A further complication is that the benefits of successful control accrue over a very long period of time, whereas the costs occur now. We can only roughly estimate how long control will last and how many cases of lung cancer might be avoided over the full term of effective control.

Instead of a quantitative cost-benefit anlaysis, we have cited examples of the impact of misuse and dispersal by wind and water in the FEIS, and have estimated the impact of radon emissions from unstabilized piles. We have then estimated the extent to which these impacts might be avoided over the long term under realistic alternative standards, and made judgments about which alternatives offer the most cost-effective reduction of these impacts. The final standards are based on the results of such an analysis of alternatives, including a detailed consideration of their costs. This information is presented in Chapters 6 and 7 of the FEIS. Based on these analyses, we have made a number of changes (described in Sections B and C, below) to make the standards more cost-effective and easier to implement.

One notable conclusion from our analysis is that providing tailings piles with thick, durable covers costs surprisingly little more than applying minimal covers that will require maintenance and last a much shorter time. This conclusion follows from the large start-up expenditures related to managing the remedial program and undertaking any significant level of remedial work at mill sites. Thick covers offer greatly increased benefits from inhibiting misuse, controlling radon emissions, and increased longevity of the covers' effectiveness. For example, we estimate that the final control standard provides about ten times greater overall benefits than the lowest cost alternative standard, for only about 25 percent greater cost. Therefore, given that tailings piles will be stabilized under any of the alternatives we considered, we find it cost-effective to stabilize them well. This observation strongly influenced our choice of a radon release standard, as discussed in Section III.B.2, below.

Cost and benefit estimates for the alternative standards we considered are reported in detail in the FEIS; we briefly summarize here only our estimates for the final standards we selected.

Costs: We estimate the remedial action costs for mill sites and for off-site cleanup will be 158 and 38 million (1981) dollars, respectively. DOE has estimated its program development and management ("overhead") costs as 118 million (1981) dollars. These estimated total expenditures of 314 million (1981) dollars will occur over a period of seven years or more.

Benefits: We estimate benefits under the assumption, when appropriate, that tailings pile control systems will be partially effective longer than the standard requires. Control systems are required to be effective for as long as reasonably achievable up to 1000 years, but for not less than 200 years. Under this standard most of the 24 tailings pile will be stable against erosion and casual intrusion for misuse for much longer than 1000 years. Those few piles that are susceptible to flood damage will be protected for at least 200 years, and might not suffer real damage for much longer. During the period of full control, the maximum risk for individuals living very near a tailings pile from exposure to its radon emissions will be reduced by about 97%, from about 3 chances in 100 to about 1 chance in 1000. An estimated 200 potential premature deaths per century will be avoided initially, for a total of many thousands over the life of the cover. The potential for or existence of water contamination from tailings piles will be evaluated and any protective or remedial actions that the implementing agencies determine are warranted will be taken. We further estimate that about 60 premature deaths will be avoided by cleaning up contaminated buildings. An undeterminable additional number of deaths and the institutional burden of applying land-use controls may be avoided by cleaning up 1900 acres of land containing windblown tailings and about 3200–6500 additional locations where tailings have been brought for inappropriate uses.

4. Scope of the Standards and the EIS. Commenters expressed the view that some important impacts of mill tailings were not adequately considered in the DEIS and that we had not considered all of the available pertinent data. They cited inadequate consideration of (a) the health impacts of toxic elements, (b) radiation doses to man from the food pathway, and (c) the effects of radionuclides and toxic elements on plants and animals.

We have reviewed the available data on toxic elements in tailings and improved the FEIS in this respect (Appendix C). We have concluded that it is reasonable to expect that hazards from toxic elements will be adequately limited if control and cleanup are carried out according to these final standards. We have also reviewed the radiation doses from ingestion of food and confirmed our earlier conclusion that the risks from this pathway are small. We have not specifically required measures to protect animals and plants from the hazards of radioactivity, since we have concluded that the impacts are small.

Some comments expressed the view that the proposed standards were too narrow in scope to adequately protect public health. For example, it was proposed that the standards should include: Limits for radionuclide concentrations in air particulates and in vegetation; limits for toxic elements in soil; guidance for the interim period prior to remedial actions; and radiation protection criteria for workers who perform remedial actions.

We have considered these comments and believe that no changes are needed. If control and cleanup are carried out according to these final standards, the health impact from radionuclides in air and from food pathways, and from toxic elements in soil, which are already low, would be further mitigated. Workers are already protected under existing Federal Guidance for occupational radiation exposures. Finally, the impacts that will occur prior to completion of remedial actions are sufficiently small that we do not believe special interim standards are justified.

B. The Standards for Control of Tailings Piles

1. Longevity of the Control. Some commenters expressed the view that the proposed requirement that stabilization and control last for at least 1000 years is unreasonable because events cannot be predicted over this period of time with sufficient certainty. They recommended a period of no more than 100 to 200 years, and that active institutional care, such as access control and periodic maintenance, be permitted. Other commenters recommended that the longevity required should be greater than 1000 years, and expressed the view that a requirement for longevity of up to 10,000 years is practical.

We consider the single most important goal of control to be effective isolation and stabilization of tailings for as long a period of time as is reasonably feasible, because tailings will remain hazardous for hundreds of thousands of years. The longevity of tailings control is governed chiefly by the possibilty of intrusion by man and erosion by natural forces. Reasonable assurance of avoiding casual intrusion by man can be provided through the use of relatively thick and/or difficult-to-penetrate covers (such as soil, rock, or soil-cement). No standard can guarantee absolute protection against the purposeful works of man, and these standards do not require such protection. Protection against natural forces requires consideration of wind and surface water erosion, and of the possibility of flood damage. Wind and surface water erosion are relatively well-understood and predictable, and are easily inhibited through the use of rock or, in some cases, vegetative surface stabilization. Similarly, a body of scientific and engineering knowledge exists to predict the frequency and magnitude of floods for periods of many hundreds of years, and to provide the engineering controls to protect against such floods (including the possibility of moving a pile if this is more economical). We considered longevity requirements ranging from 100 to 10,000 years and have concluded that existing knowledge permits the design of control systems for these tailings that have a good expectation of lasting at least for periods of 1000 years. We recognize that it may not always be practical, however, to project such performance with a high degree of certainty, because of limited engineering experience with such long time periods.

We know no historical examples of societies successfully maintaining active care of decentralized materials through public institutions for periods extending to many hundreds or thousands of years. We have concluded that primary reliance on passive measures is preferable, since their long-term performance can be projected with more assurance than that of measures which rely on institutions and continued expenditures for active maintenance.

Section 104 of the Act requires the Federal Government to acquire and retain control of these tailings disposal sites under licenses issued by the Nuclear Regulatory Commission (NRC). The NRC is authorized to require performance of any maintenance, monitoring, and emergency measures that are needed to protect public health and safety. As long as the Federal Government exercises its ownership rights and other authorities regarding these sites, they should not be systematically exploited by people or severely degraded by natural forces.

We believe that these institutional provisions are essential to support any project whose objectives is as long term as are these disposal operations, and for which we have as little experience. This does not mean that we believe primary reliance should be placed on institutional controls; rather, that institutional oversight is an essential backup to passive control. We note, in this regard, that the remedial actions required by these standards would not make it safe to build habitable structures on the disposal sites. Federal ownership of the sites is assumed to preclude such inappropriate uses.

In the final standards we have modified the requirement for longevity of control so as to assure that it is practical for agencies to certify that the standards are implemented in all cases. We recognize that this is a remedial action program, that these sites were not chosen with long-term disposal in mind, and that our ability to predict the longevity of engineered designs is not always adequate to the task at hand. The proposed standard required a longevity of control of at least 1000 years. The final standard requires that control measures be carried out in a manner that provides reasonable assurance that they will last, to the extent reasonably achievable, up to 1000 years and, in any case, for a minimum of 200 years. The widely varying characteristics of the inactive sites, the uncertainties involved in projecting performance of control measures over long periods of time, and the large costs involved in moving some tailings piles to provide a very high degree of assurance of longevity make this change appropriate. (We estimate up to 50 million dollars might be unnecessarily spent to move piles under the proposed requirement for a longevity of at least 1000 years.) The change does not signify that there are circumstances under which the term of protection contemplated by the proposed standards is not appropriate. The change merely acknowledges that implementing agencies may in some cases have difficulty certifying that control measures that are appropriate can reasonably be expected to endure without degradation for 1000 years. Man's ability to predict the future is notoriously limited. That fact, which on the one hand warrants our making responsible societal efforts to limit risk to future generations, also warrants our refraining from actions undertaken merely in the name of necessarily artificial levels of statistical certainty.

We selected this period of period of performance because we believe there is a reasonable expectation that readily achievable controls will remain effective for at least this period. However, we recognize that uncertainties increase significantly beyond a thousand years, and we conclude it would be unreasonable to require that assurance be provided that the controls will be effective for periods of up to 10,000 years.

2. The Radon Release Limit. Some commenters expressed the view that the proposed radon emission standard of 2 pCi/m²s from the surface of a tailings pile was either unreasonably low or unnecessary. Others suggested that proper consideration of costs and benefits would lead to a higher standard, in the range of 40–100 pCi/m²s. Some urged that the standards for radon be expressed as a limit on ambient air concentration at the site boundary, rather than as an emission limit. Others were concerned that the proposed level could not be reliably implemented, since it is close to background levels. Finally, many argued that radon emitted from tailings piles does not constitute a significant health hazard because it cannot be distinguished from background radon levels a short distance from a tailings pile (i.e., ¼–½ mile), and that, therefore, there is no need for a radon emission standard.

We believe that limiting radon emissions from tailings piles serves several necessary functions: reducing the risk to nearby individuals and individuals at greater distances; and furthering the goals of reliable long-term deterrence of misuse of tailings by man and control of erosion of piles by natural processes. The degree of reduction of radon emissions achieved by a disposal system is more or less directly related to the degree of abatement of each of these hazards.

Our analysis predicts significant risk to people living next to tailings piles, and field measurements confirm elevated levels of radon in air close to the piles. If radon emissions are not reduced, we estimate that individuals residing permanently near some of the piles could incur as much as three to four chances in a hundred of a fatal lung cancer in addition to normal expectations. The fact that increases in radon levels due to the piles cannot be distinguished relative to background levels further away from a pile does not mean that radon is not present or that there is no increased risk from this radon—it merely means that measurements are not capable of unambiguously detecting such levels. Limiting radon release, therefore, not only benefits the nearby individual, but also reduces the adverse effects of radon well beyond the immediate vicinity of the site.

Radon emission was selected as the preferred quantity to be specified by the standard because, unlike ambient air concentration at the site boundary, it is directly related to the degree of radon control achieved. A site boundary standard would not necessarily require any control of radon emissions (since the boundary might be moved arbitrarily far from the pile), and, in any case, compliance would depend on indefinitely excluding public access across the boundary.

We have concluded that a limit on a radon emission is the most direct and appropriate means for furthering the Congressional objective of adequate and reliable long-term control of tailings. Such a limit assures a sufficient earthen cover (or its equivalent) to provide an acceptable degree of stabilization and isolation of the tailings over a long period of time. Congress did not intend that EPA set standards for one generation only, or that it set standards without consideration of the long-term reliability of whatever means are available for implementing them. (Similarly, Congress anticipated that short-term institutional controls would not provide the primary basis for protection.) Although the implementing agencies will decide which specific controls to employ, this does not preclude our considering, in accordance with Congress' directive, the effect of a particular choice of a numerical limit on the maintenance of future control. Therefore, in selecting the value for radon emissions, an important consideration was that the standard promote the objectives of adequate isolation and stabilization to control both intrusion by man and erosion by natural forces.

We have reevaluated the costs and benefits of alternative standards and have revised the radon emission standard to 20 pCi/m²s, in part because we concluded that the incremental benefits of the proposed standards are not justified by the increased costs, and in part because recent results of tests of covers indicate that a 2 pCi/m²s standard may be more difficult to achieve than we originally believed. The specific alternatives we analyzed are described in detail in the FEIS. They ranged from controlling emissions to 2 pCi/m²s to providing only a minimal cover that we estimate would, on the average, reduce total radon emissions by half (to final values ranging from 40 pCi/m²s to 500 pCi/m²s, depending upon the site.) Estimated disposal costs for these options (excluding DOE overhead and the cost of moving piles) range from 50 to 195 million dollars. The costs for the revised standard of 20 pCi/m²s were estimated as 95 million dollars; this is approximately 45 million dollars less than for the proposed standard.

We have concluded that this revised standard will provide excellent protection of public health, safety, and the environment. Control measures designed to meet this standard will prevent misuse and protect piles from erosion by providing adequate isolation of tailings. The standard provides more than 96% of the reduction of the potential for lung cancer from radon emissions provided by the proposed standard. Under the revised emission limit, the excess risk to the most exposed individual would be reduced to a few chances in a thousand. In addition, it provides this protection at a substantial cost reduction compared to the originally proposed standard (including the modification of the longevity requirement, the combined saving is approximately 95 million

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dollars). The revised emission limit should also be high enough to remove any concern associated with confusing radon from tailings with radon emitted from normal soils (typically up to 1 pCi/m²s), and can be readily achieved through the use of a wider variety of earthen materials than the proposed standards.

We conclude from our analysis that a higher emission standard, such as 100 pCi/m²s, would not achieve the above objectives to an acceptable degree. It would result in a five times greater risk to individuals living near a tailings pile and a similar increase in the impact from radon emissions on local, regional, and national populations (to 20% of the total risk from uncontrolled piles). The control measures required to meet such a less restrictive standard would provide significantly less isolation against intrusion and protection against erosion. The further cost reduction compared to the final standard would be relatively small (approximately 20 million dollars).

The Department of Energy, in the course of the consultations that Section 206 of the Act requires before we promulgate final standards, expressed its strong preference for an ambient air concentration standard rather than an emission standard. Therefore, through calculations described in the FEIS, we determined an alternative standard expressed as a radon concentration at the *edge of the tailings* that we believe would require basically the same level of control as the 20 pCi/m²s emission standard. Applying a concentration standard at the edge of the tailings resolves our concerns about applying it at a site boundary. A limit applied at a site boundary would permit varying effectiveness of cover, depending on the choice of location of the boundary, and compliance would depend on indefinite maintenance of the boundary. However, a radon concentration standard at any position that is defined in terms of its relation to the tailings has a fixed relationship to radon releases and compliance does not depend on institutional maintenance of a fence.

Calculations can be used to estimate the values of the annual average radon concentrations at various distances from tailings piles with a given emission rate. Considering the uncertainties in such calculations, we are confident that designing control systems to keep the maximum annual average radon concentration at the edges of the tailings below 0.5 pCi/1 will provide approximately the same overall health protection as designing them for an average emission rate of 20 pCi/m²s.

Under either form of the radon limit the radon concentration due to a pile will be well below the background level at any residence near the disposal site. The final standard contains both forms of radon limit, as approximately equivalent alternatives.

3. Avoiding Contamination of Water. Commenters expressed concern that the proposed requirements for protection of water are unnecessarily restrictive, are impractical or too costly to implement, or incorporate numerical values that had not been adequately justified. Some argued that water protection should be handled on a site-specific basis, that general standards were not necessary, and that water quality standards were not an appropriate basis for these regulations. Other comments expressed the opposite view that the proposed standards did not provide sufficient protection, that already degraded ground water should be cleaned up, or that numerical values should be included for additional toxic elements.

We have carefully reviewed available data on contamination of ground water at the designated sites. Studies of these sites are not yet conclusive, but they provide little evidence of recent movement of contaminants into ground water, and there is some evidence that the geochemical setting may inhibit contaminants from entering usable ground water at two sites where there might otherwise be a problem (Salt Lake City and Canonsburg). The proposed standards might be difficult to implement at certain sites because our ability to perform definitive hydrological assessments is limited. That is, they could lead to decisions to use very expensive control methods, such as moving piles to new sites and installing liners, even though no substantial threat to ground water is demonstrated. We also believe that minor degradation of ground water may be acceptable, such as for water of already inadequate quality for existing or probable uses, or for very small aquifers.

Finally, we agree that there is uncertainty associated with the appropriateness of both the toxic elements selected and the numerical values specified in the proposed standards, which were drawn mainly from existing national water quality standards for surface water and public drinking water supplies.

In summary, although a few sites appear to have some existing ground water contamination, probably due to dewatering of process liquids from the tailings, we believe there is a low probability of additional contamination at most of the sites. The remedial program should provide for adequate hydrological and geochemical surveys of each site as a basis for determining whether specific water protection or cleanup measures should be applied. Whether or not it is feasible or practical to restore an aquifer and to what degree will depend on site-specific factors, including the aquifer's hydrogeologic setting, the cost, the present and future value of the aquifer as a water resource, the availability of alternative supplies, and the degree to which human exposure is likely to occur.

We do not believe that the existing evidence indicates that ground water contamination from inactive mill tailings is or will be a matter of regulatory concern. We have decided, therefore, not to establish general substantive standards on this subject. Should evidence be found that shows that this judgment is in error, we will consider the need for further rulemaking procedures.

A possible alternative to the above course of action is for us to establish a general regulatory mechanism for others to use in deciding, on a site-specific basis, whether a ground water problem exists and, if so, what remedial action is appropriate. Such a nonsubstantive, or procedural, mechanism would resemble that established by our regulations implementing the Solid Waste Disposal Act, as amended (47 FR 32274, July 26, 1982). In this connection, the Uranium Mill Tailings Radiation Control Act reflects the desire of Congress (in Section 206) that EPA's standards be consistent, to the maximum extent practicable, with the Solid Waste Disposal Act. It also requires NRC to concur in DOE's remedial actions at each site (in Section 108) and to issue licenses for these sites (in Section 104) that may encompass any ". . . monitoring, maintenance, or emergency measures necessary to protect public health and safety." These functions are consistent with those embodied in EPA's above-referenced regulations. We have decided not to adopt this alternative, because we believe that the devising of any necessary such mechanisms for application under this Act can more appropriately be left to the NRC and DOE.

If any existing contamination or potential for future ground water contamination is present we have provided, therefore, in the implementation section of these standards, that judgments on the possible need for monitoring or remedial actions should be guided by relevant considerations described in EPA's hazardous waste management system.

and by relevant State and Federal Water Quality Criteria for existing and anticipated uses of the aquifer. Decisions to undertake remediation should consider the costs and benefits of possible remedial and control measures, including the extent and usefulness of the aquifer. We have also concluded that the same approach is appropriate to surface water, which should be adequately protected in any case by any control measures meeting the standards for longevity and radon emission.

C. The Standards for Cleanup of Tailings

1. Radium-226 in Soil. Comments about the cleanup standard for radium-226 in soil dealt primarily with the proposed numerical value of the standard and perceived difficulty of measurement to show conformance. Many comments expressed the view that there was no justification for a standard as low as 5 pCi/g and that a higher value would be most cost-effective. Recommended values ranged from 10–30 pCi/g.

The purpose of this standard is to limit the risk from inhalation of radon decay products in houses built on land contaminated with tailings, and to limit gamma radiation exposure of people using contaminated land. We estimate that each increase of 0.01 WL inside a house increases the risk of lung cancer to each of its inhabitants by something like one-half to one in a hundred, for an assumed lifetime of residency. The infiltration of radon in soil gas directly into a house is by far the largest contributor to indoor radon, and we estimate that soil extensively contaminated at a level of 5 pCi/g radium can readily lead to indoor levels of radon decay products of 0.02 WL. Because the risks from soils contaminated with radium-226 are potentially so great, the proposed standard was set at a level as close to background as we believed reasonable, taking into consideration the difficulties in measuring this level and distinguishing it from natural backgound.

We have examined the costs and benefits of alternative standards ranging from 5 to 30 pCi/g. These are described in detail in the FEIS. Total cleanup costs are less than 10% to 20% of the total costs of disposal of tailings piles for all the alternatives considered. Costs for cleanup of windblown tailings from land surfaces are sensitive to the standard, because the area to be cleaned up varies approximately inversely with the limit selected. Costs for removal of buried tailings are not sensitive to the standard, since the amount to be removed varies only slightly with the limit selected. That is, we concluded most buried tailings would be removed under any of the alternatives considered. We also considered the difficulty of measuring various thicknesses of surface contamination, and in identifying and measuring contamination due to buried tailings. Detection of buried tailings could be difficult. However, buried tailings, as opposed to surface contaimination (usually windblown and diluted with soil), can be effectively located using a higher detection limit than the proposed standard of 5 pCi/g. Based on these analyses, we have modified the standard for surface contamination of soil (5 pCi/g) from an average over the top 5 cm of soil to an average over the top 15 cm of soil; and revised the standard for subsurface contamination from 5 pCi/g to 15 pCi/g (still averaged over any 15 cm layer of soil). We believe these standards will result in essentially the same degree of cleanup, and will be simpler to implement.

For tailings transported by man to off-site properties, the hazard varies with the amount of tailings involved and their location. The proposed standard did not provide for exemption of locations posing a low hazard. The final standard requires cleanup of contamination only when the amount and location of tailings poses a clear present or future hazard, and provides criteria to assist this determination. We estimate that perhaps more than half of the identified locations of such contamination do not present a hazard sufficient to warrant cleanup, at an estimated saving of 24 million dollars.

Some comments expressed the view that measuring radium-226 and distinguishing residual radioactive materials from natural background at the levels proposed would be difficult and costly, and that many samples would have to be collected and analyzed to show compliance with the standards. The changes we have made make determination of compliance with the standard easier and less costly. In addition, we have provided guidance in this Notice and the FEIS on implementation of the standards, to clarify our intent that unnecessarily stringent (and costly) verification that the standards have been achieved should be avoided.

2. Radon Decay Products in Buildings. Some comments expressed the view that the proposed indoor radon decay product standard of 0.015 WL would be difficult and costly to implement, because it is within the upper range of levels that commonly occur in houses due to natural causes. For example, it might be necessary to distinguish whether the standard is exceeded because of the presence of tailings or because of anomalies in the natural background. This could result in costly and unnecessary remedial actions, or in the frequent use of an exceptions procedure. These comments recommended that we raise this standard to a more cost-effective value that can be more easily distinguished from naturally-occurring levels.

We have considered these arguments and re-examined the costs and benefits of alternative standards. We used the data from the Grand Junction, Colorado, remedial program for contaminated buildings to assist this evaluation. Reduction of radon decay products in existing buildings is probably the most cost-effective of all types of remedial actions for tailings, because the high risk associated with indoor radon decay products. Based on these evaluations, the standard has been revised upward only slightly so as to facilitate implementation and to more closely conform to other related standards. Under the final standard the objective of remedial actions is to achieve an indoor radon decay product concentration of 0.02 WL. For circumstances where remedial action has been performed and it would be unreasonably difficult and costly to reduce the level below 0.03 WL, the remedial action may be terminated at this level without a specific finding of the need for an exception. However, we have also sought to avoid excessive costs by encouraging the use of active measures (such as heat exchangers, air cleaners, and sealants) to meet the objective of 0.02 WL when further removal of tailings to achieve levels below 0.03 WL is impractical. We believe the final standard deals adequately with complications introduced by the presence of any high concentration of naturally-occurring radionuclides, and avoids unnecessary and costly remedial actions that produce only marginal improvements.

D. Reducing Regulatory Burdens. Some commenters suggested that the proposed standards should be flexible to take account of unusual circumstances, site-specific factors, and any complications due to high natural background levels. These commenters recommended that this be accomplished by raising the numerical limits, establishing different standards for unusual circumstances, or by expressing the standards as a range of values.

We agree that it is appropriate and desirable to take into account, as far as practical, different circumstances. In addition, we believe that regulations should be easy to carry out and not contain unnecessary procedural requirements. We have encouraged the implementing agencies to do this in our "Guidance for Implementation" as described below. We have also changed the procedures for situations in which it would be unreasonable to satisfy the standards from an "exceptions" process to one in which the implementing agencies apply "Supplemental Standards." This is also described below. Finally, the numerical limits of some of the standards have been raised; this will assure that they are more readily distinguishable from background levels.

IV. Implementation.

The Act requires the Secretary of Energy to select and perform the remedial actions needed to implement these standards, with the full participation of any State that shares the cost, with the concurrence of the Nuclear Regulatory Commission, and in consultation, when appropriate, with affected Indian tribes and the Secretary of the Interior.

The cost of remedial action will be borne by the Federal Government and the States as prescribed by the Act. Control and stabilization remedial activities are large scale undertakings for which there is relatively little experience. Although preliminary engineering assessments have been performed, specific engineering requirements and costs to meet the standards at each site have yet to be determined. We believe control and stabilization costs (including DOE overhead) averaging about 10–12 million (1981) dollars per tailings pile are most likely. For some sites, this cost may be partly offset by recovered land values or through provisions of the Act for recovery of uranium or other minerals through reprocessing the tailings prior to performing remedial actions.

A. Guidance for Implementation

Conditions at the inactive processing sites vary greatly, and engineering experience with some of the required remedial actions is limited. It is our objective that implementation of these standards be consistent with the assumptions we have made in deriving them. We are therefore providing "Guidance for Implementation" to avoid needless expense which may result from uncertainty or confusion as to what level of protection the standards are intended to achieve.

The standard for control and stabilization of tailings piles is primarily intended as a design standard. Implementation will require a judgment that the method chosen provides a reasonable expectation that the provisions of the standard will be met, to the extent reasonably achievable, for up to 1000 years, and, in any case, for at least 200 years. This judgment will necessarily be based on site-specific analyses of the properties of the sites, candidate control systems, and the potential effects of natural processes over time, and, therefore, the measures required to satisfy the standard will vary from site to site. We expect that computational models, theories, and expert judgment will be the major tools in deciding that a proposed control system will adequately satisfy the standard. Post-remediation monitoring will not be required to show compliance, but may serve a useful role in determining whether the anticipated performance of the control system is achieved.

The purpose of our cleanup standards is to provide the maximum reasonable protection of public health and the environment. Costs incurred by remedial actions should be directed toward this purpose. We intend the standards to be implemented using search and verification procedures whose cost and technical requirements are reasonable. For example, since we intend the cleanup standards for buildings to protect people, measurements in such locations as small crawl spaces and furnace rooms may often be inappropriate. Remedial action decisions should be based on radiation levels in the parts of buildings where people spend substantial amounts of time. The standards for cleanup of land are designed to limit the exposure of people to gamma radiation, and to limit the level of radon decay products in buildings that might later be built on the land. In most circumstances, no significant harm would be caused by not cleaning up small areas of land contaminated by tailings. Similarly, it would be unreasonable to require expensive detailed proof that all the tailings below the surface of open lands had been removed. Procedures that provide a reasonable assurance of compliance with the standards will be adequate. Where measurements are necessary to determine compliance with the cleanup standards, they should be performed within the accuracy of presently available field and laboratory measurement capabilities and in conjunction with reasonable survey and sampling procedures designed to minimize the cost of verification. We are confident that DOE and NRC, in consultation with EPA and the States, will adopt implementation procedures consistent with our intent in establishing these standards.

B. Supplemental Standards

The varied conditions at the designated sites and limited experience with remedial actions make it appropriate that EPA allow adjustment of the standards where circumstances require. We believe that, in most cases, our final standards are adequately protective and can be implemented at reasonable cost. However, the standards could be too strict in some applications. We anticipate that such circumstances might occur. We originally proposed to deal with this through an "exceptions" procedure which would relax standards when certain criteria were satisfied. We agree with the comments, however, that the proposed procedure was unnecessarily burdensome to apply.

In the final regulations we have eliminated this procedure and replaced it with a simplified procedure for applying "supplemental standards." This is a more effective means of accomplishing our original purpose. An additional significant change in the proposed criteria for exceptions is the addition of criterion 192.21(c), which relaxes the requirement for cleanup of land at off-site locations when residual radioactive materials are not clearly hazardous and cleanup costs are unreasonably high. This category of contamination was not adequately addressed in the proposals.

Regulatory Impact Analysis

Under Executive Order 12291, EPA must judge whether a regulation is "Major" and therefore subject to the requirement of a Regulatory Impact Analysis. That order requires such an analysis if the regulations would result in (1) an annual effect on the economy of $100 million or more; (2) a major increase in costs or prices for consumers, individual industries, Federal, State, or local government agencies or geographic regions; or (3) significant adverse effects on competition, employment, investment, productivity, innovation, or on the ability of United States-based enterprises to compete with foreign-based enterprises in domestic or export markets.

This regulation is not Major, because we expect the costs of the remedial action program in any calendar year to be less than $100 million; States bear only 10% of these costs and there are no anticipated major effects on costs or prices for others; and we anticipate no significant adverse effects on domestic or foreign competition, employment, investment, productivity, or innovation. The costs of these standards are discussed in the FEIS.

This regulation was submitted to the Office of Management and Budget for review as required by Executive Order 12291.

This regulation will not have a significant effect on a substantial number of small entities, as specified under Section 605 of the Regulatory Flexibility Act, because there are no small entities subject to this regulation.

Dated: December 15, 1982.

Anne M. Gorsuch,

Administrator.

List of Subjects in 40 CFR Part 192

Environmental protection; Radiation protection; Uranium.

In 40 CFR Chapter I, Part 192 is revised to read as follows:

PART 192—HEALTH AND ENVIRONMENTAL PROTECTION STANDARDS FOR URANIUM MILL TAILINGS

Subpart A—Standards for the Control of Residual Radioactive Materials from Inactive Uranium Processing Sites

Subpart B—Standards for Cleanup of Land and Buildings Contaminated with Residual Radioactive Materials from Inactive Uranium Processing Sites

Subpart C—Implementation

Authority: Section 275 of the Atomic Energy Act of 1954, 42 U.S.C. 2022, as added by the Uranium Mill Tailings Radiation Control Act of 1978, Pub. L. 95-604.

Subpart A—Standards for the Control of Residual Radioactive Materials from Inactive Uranium Processing Sites

§ 192.00 Applicability

This subpart applies to the control of residual radioactive material at designated processing or depository sites under Section 108 of the Uranium Mill Tailings Radiation Control Act of 1978 (henceforth designated "the Act"), and to restoration of such sites following any use of subsurface minerals under Section 104(h) of the Act.

§ 192.01 Definitions

(a) Unless otherwise indicated in this subpart, all terms shall have the same meaning as in Title I of the Act.

(b) *Remedial* action means any action performed under Section 108 of the Act.

(c) *Control* means any remedial action intended to stabilize, inhibit future misuse of, or reduce emissions or effluents from residual radioactive materials.

(d) *Disposal site* means the region within the smallest perimeter of residual radioactive material (excluding cover materials) following completion of control activities.

(e) *Depository site* means a disposal site (other than a processing site) selected under Section 104(b) or 105(b) of the Act.

(f) *Curie* (Ci) means the amount of radioactive material that produces 37 billion nuclear transformation per second. One picocurie (pCi) = 10^{-12}Ci.

§ 192.02 Standards

Control shall be designed[4] to:

(a) Be effective for up to one thousand years, to the extent reasonably achievable, and, in any case, for at least 200 years, and,

(b) Provide reasonable assurance that releases of radon-222 from residual radioactive material to the atmosphere will not:

(1) Exceed an average [5] release rate of 20 picocuries per square meter per second, *or*

(2) Increase the annual average concentration of radon-222 in air at or above any location outside the disposal site by more than one-half picocurie per liter.

Subpart B—Standards for Cleanup of Land and Buildings Contaminated with Residual Radioactive Materials from Inactive Uranium Processing Sites

§ 192.10 Applicability

This subpart applies to land and buildings that are part of any processing site designated by the Secretary of Energy under Section 102 of the Act. Section 101 of the Act, states, in part, that "processing site" means—

(a) Any site, including the mill, containing residual radioactive materials at which all or substantially all of the uranium was produced for sale to any Federal agency prior to January 1, 1971, under a contract with any Federal agency, except in the case of a site at or near Slick Rock, Colorado, unless—

(1) Such site was owned or controlled as of Januray 1, 1978, or is thereafter owned or controlled, by any Federal agency, or

(2) A license (issued by the (Nuclear Regulatory) Commission or its predecessor agency under the Atomic Energy Act of 1954 or by a State as permitted under Section 274 of such Act) for the production at site of any uranium or thorium product derived from ores is in effect on January 1, 1978, or is issued or renewed after such date; and

(b) Any other real property or improvement thereon which—

(1) Is in the vicinity of such site, and

(2) Is determined by the Secretary, in consultation with the Commission, to be contaminated with residual radioactive materials derived from such site.

§ 192.11 Definitions

(a) Unless otherwise indicated in this subpart, all terms shall have the same meaning as defined in Title I of the Act or in Subpart A.

(b) "Land" means any surface or subsurface land that is not part of a disposal site and is not covered by an occupiable building.

(c) "Working Level" (WL) means any combination of short-lived radon decay products in one liter of air that will result in the ultimate emission of alpha particles with a total energy of 130 billion electron volts.

(d) "Soil" means all unconsolidated materials normally found on or near the surface of the earth including, but not limited to, silts, clays, sands, gravel, and small rocks.

§ 192.12 Standards

Remedial actions shall be conducted so as to provide reasonable assurance that, *as a result of residual radioactive materials from any designated processing site:*

(a) The concentration of radium-226 in land averaged over any area of 100 square meters shall not exceed the background level by more than—

(1) 5 pCi/g, averaged over the first 15 cm of soil below the surface, and

(2) 15 pCi/g, averaged over 15 cm thick layers of soil more than 15 cm below the surface.

(b) In any occupied or habitable building—

(1) The objective of remedial action shall be, and reasonable effort shall be made to achieve, an annual average (or

[4] Because the standard applies to design, monitoring after disposal is not required to demonstrate compliance.

[5] This average shall apply over the entire surface of the disposal site and over at least a one-year period. Radon will come from both residual radioactive materials and from materials covering them. Radon emissions from the covering materials should be estimated as part of developing a remedial action plan for each site. The standard, however, applies only to emissions from residual radioactive materials to the atmosphere.

equivalent) radon decay product concentration (including background) not to exceed 0.02 WL. In any case, the radon decay product concentration (including background) shall not exceed 0.03 WL, and

(2) The level of gamma radiation shall not exceed the background level by more than 20 microroentgens per hour.

Subpart C—Implementation

§ 192.20 Guidance for implementation

Section 108 of the Act requires the Secretary of Energy to select and perform remedial actions with the concurrence of the Nuclear Regulatory Commission and the full participation of any State that pays part of the cost, and in consultation, as appropriate, with affected Indian Tribes and the Secretary of the Interior. These parties, in their respective roles under Section 108, are referred to hereafter as "the implementing agencies." The implementing agencies shall establish methods and procedures to provide "reasonable assurance" that the provisions of Subparts A and B are satisfied. This should be done as appropriate through use of analytic models and site-specific analyses, in the case of Subpart A, and for Subpart B through measurements performed within the accuracy of currently available types of field and laboratory instruments in conjunction with reasonable survey and sampling procedures. These methods and procedures may be varied to suit conditions at specific sites. In particular:

(a)(1) The purpose of Subpart A is to provide for long-term stabilization and isolation in order to inhibit misuse and spreading of residual radioactive materials, control releases of radon to air, and protect water. Subpart A may be implemented through analysis of the physical properties of the site and the control system and projection of the effects of natural processes over time. Events and processes that could significantly affect the average radon release rate from the entire disposal site should be considered. Phenomena that are localized or temporary, such as local cracking or burrowing of rodents, need to be taken into account only if their cumulative effect would be significant in determining compliance with the standard. Computational models, theories, and prevalent expert judgment may be used to decide that a control system design will satisfy the standard. The numerical range provided in the standard for the longevity of the effectiveness of the control of residual radioactive materials allows for consideration of the various factors affecting the longevity of control and stabilization methods and their costs. These factors have different levels of predictability and may vary for the different sites.

(2) Protection of water should be considered in the analysis for reasonable assurance of compliance with the provisions of § 192.02. Protection of water should be considered on a case-specific basis, drawing on hydrological and geochemical surveys and all other relevant data. The hydrologic and geologic assessment to be conducted at each site should include a monitoring program sufficient to establish background ground water quality through one or more upgradient wells, and identify the presence and movement of plumes associated with the tailings piles.

(3) If contaminants have been released from a tailings pile, an assessment of the location of the contaminants and the rate and direction of movement of contaminated ground water, as well as its relative contamination, should be made. In addition, the assessment should identify the attenuative capacity of the unsaturated and saturated zone to determine the extent of plume movement. Judgments on the possible need for remedial or protective actions for groundwater aquifers should be guided by relevant considerations described in EPA's hazardous waste management system (47 FR 32274, July 26, 1982) and by relevant State and Federal Water Quality Criteria for anticipated or existing uses of water over the term of the stabilization. The decision on whether to institute remedial action, what specific action to take, and to what levels an aquifer should be protected or restored should be made on a case-by-case basis taking into account such factors as technical feasibility of improving the aquifer in its hydrogeologic setting, the cost of applicable restorative or protective programs, the present and future value of the aquifer as a water resource, the availability of alternative water supplies, and the degree to which human exposure is likely to occur.

(b)(1) Compliance with Subpart B, to the extent practical, should be demonstrated through radiation surveys. Such surveys may, if appropriate, be restricted to locations likely to contain residual radioactive materials. These surveys should be designed to provide for compliance averaged over limited areas rather than point-by-point compliance with the standards. In most cases, measurement of gamma radiation exposure rates above and below the land surface can be used to show compliance with § 192.12(a). Protocols for making such measurements should be based on realistic radium distributions near the surface rather than extremes rarely encountered.

(2) In § 192.12(a), "background level" refers to the native radium concentration in soil. Since this may not be determinable in the presence of contamination by residual radioactive materials, a surrogate "background level" may be established by simple direct or indirect (e.g., gamma radiation) measurements performed nearby but outside of the contaminated location.

(3) Compliance with § 192.12(b) may be demonstrated by methods that the Department of Energy has approved for use under Pub. L. 92–314 (10 CFR 712), or by other methods that the implementing agencies determine are adequate. Residual radioactive materials should be removed from buildings exceeding 0.03 WL so that future replacement buildings will not pose a hazard [unless removal is not practical—see § 192.21(c)]. However, sealants, filtration, and ventilation devices may provide reasonable assurance of reductions from 0.03 WL to below 0.02 WL. In unusual cases, indoor radiation may exceed the levels specified in § 192.12(b) due to sources other than residual radioactive materials. Remedial actions are not required in order to comply with the standard when there is reasonable assurance that residual radioactive materials are not the cause of such an excess.

§ 192.21 Criteria for applying supplemental standards

The implementing agencies may (and in the case of Subsection (f) shall) apply standards under § 192.22 in lieu of the standards of Subparts A or B if they determine that any of the following circumstances exists:

(a) Remedial actions required to satisfy Subparts A or B would pose a clear and present risk of injury to workers or to members of the public, notwithstanding reasonable measures to avoid or reduce risk.

(b) Remedial actions to satisfy the cleanup standards for land, § 192.12(a), or the acquisition of minimum materials required for control to satisfy § 192.02(b), would, notwithstanding reasonable measures to limit damage, directly produce environmental harm that is clearly excessive compared to the health benefits to persons living on or near the site, now or in the future. A clear excess of environmental harm is harm that is long-term, manifest, and grossly disproportionate to health benefits that may reasonably be anticipated.

(c) The estimated cost of remedial action to satisfy § 192.12(a) at a "vicinity" site (described under Sec. 101(6)(B) of the Act) is unreasonably high relative to the long-term benefits, and the residual radioactive materials do not pose a clear present or future hazard. The likelihood that buildings will be erected or that people will spend long periods of time at such a vicinity site should be considered in evaluating this hazard. Remedial action will generally not be necessary where residual radioactive materials have been placed semi-permanently in a location where site-specific factors limit their hazard and from which they are costly or difficult to remove, or where only minor quantities of residual radioactive materials are involved. Examples are residual radioactive materials under hard surface public roads and sidewalks, around public sewer lines, or in fence post foundations. Supplemental standards should not be applied at such sites, however, if individuals are likely to be exposed for long periods of time to radiation from such materials at levels above those that would prevail under § 192.12(a).

(d) The cost of a remedial action for cleanup of a building under § 192.12(b) is clearly unreasonably high relative to the benefits. Factors that should be included in this judgment are the anticipated period of occupancy, the incremental radiation level that would be affected by the remedial action, the residual useful lifetime of the building, the potential for future construction at the site, and the applicability of less costly remedial methods than removal of residual radioactive materials.

(e) There is no known remedial action.

(f) Radionuclides other than radium-226 and its decay products are present in sufficient quantity and concentration to constitute a significant radiation hazard from residual radioactive materials.

§ 192.22 Supplemental standards

Federal agencies implementing Subparts A and B may in lieu thereof proceed pursuant to this section with respect to generic or individual situations meeting the eligibility requirements of § 192.21.

(a) When one or more of the criteria of § 192.21(a) through (e) applies, the implementing agencies shall select and perform remedial actions that come as close to meeting the otherwise applicable standard as is reasonable under the circumstances.

(b) When § 192.21(f) applies, remedial actions shall, in addition to satisfying the standards of Subparts A and B, reduce other residual radioactivity to levels that are as low as is reasonably achievable.

(c) The implementing agencies may make general determinations concerning remedial actions under this Section that will apply to all locations with specified characteristics, or they may make a determination for a specific location. When remedial actions are proposed under this Section for a specfic location, the Department of Energy shall inform any private owners and occupants of the affected location and solicit their comments. The Department of Energy shall provide any such comments to the other implementing agencies. The Department of Energy shall also periodically inform the Environmental Protection Agency of both general and individual determinations under the provisions of this section.

§ 192.23 Effective date.

Subparts A, B, and C shall be effective March 7, 1983.

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ENVIRONMENTAL PROTECTION AGENCY

40 CFR Part 192

[A-FRL 2211-8b]

Standards for Remedial Actions at Inactive Uranium Processing Sites, Advance Notice of Proposed Rulemaking

AGENCY: Environmental Protection Agency (EPA).

ACTION: Advance Notice of Proposed Rulemaking.

SUMMARY: EPA has issued final remedial action standards (40 CFR Part 192, Subpart A) for the control of tailings piles at inactive uranium processing sites. This notice announces that the Agency will consider whether different standards than 40 CFR Part 192, Subpart A would be more appropriate for control of tailings piles at those designated sites that have been established as having "medium" or "low" priority for carrying out remedial actions. Specifically, since most of these sites have much lower population densities than the "high" priority sites, 1) should the standards be less restrictive at such sites, and/or 2) should the standards place primary reliance on control of access (such as through fences) rather than physical control of tailings (such as by thick earthen covers) to avoid radiation exposure, so as to reduce the costs of disposal of tailings at these sites?

DATE: Comments are due by May 5, 1983.

ADDRESS: Comments on the issue described in this notice should be submitted to Docket No. A-79-25, which is located at the Environmental Protection Agency, Central Docket Section (A-130), West Tower Lobby, 401 M Street, S.W., Washington, D.C. 20460. Docket A-79-25 contains the rulemaking records. The Docket is available for public inspection between 8:00 a.m. and 4:00 p.m., Monday through Friday. A reasonable fee may be charged for copying.

FOR FURTHER INFORMATION CONTACT: Dr. Stanley Lichtman, Guides and Criteria Branch (ANR-460), Office of Radiation Programs, U.S. Environmental Protection Agency, Washington, D.C. 20460; telephone 703-557-8927.

SUPPLEMENTARY INFORMATION:

Background

On November 8, 1978, Congress enacted the Uranium Mill Tailings Radiation Control Act of 1978, Pub. L. 95-604 (henceforth designated "the Act"). In the Act, Congress stated its finding that uranium mill tailings ". . . may pose a potential and significant radiation health hazard to the public, . . . and . . . that every reasonable effort should be made to provide for stabilization, disposal, and control in a safe and environmentally sound manner of such tailings in order to prevent or minimize radon diffusion into the environment and to prevent or minimize other environmental hazards from such tailings." The Administrator of the Environmental Protection Agency was directed to set ". . . standards of general application for the protection of the public health, safety, and the environment . . ." to govern this process of stabilization, disposal, and control.

The Act directs the Department of Energy (DOE) to conduct necessary remedial actions at designated inactive uranium processing sites to achieve compliance with the general standards established by EPA. Standards are required for two types of remedial actions: control and cleanup. Control is the operation which places the tailings piles in a condition that will minimize the risk to man for a long time. Cleanup is the operation which reduces the potential health consequences of tailings that have been dispersed from tailings piles by natural forces or removed by man and used elsewhere in buildings or land.

In another part of this issue we have promulgated such standards (40 CFR Part 192). Subparts A and B of the standards cover control and cleanup, respectively; Subpart C addresses implementation of Subparts A and B. This notice concerns only Subpart A, the standards for control of tailings piles.

DOE has designated 24 inactive mill sites for remedial actions under the Act (44 FR 74892, December 18, 1979). Furthermore, as required by Section 102(b) of the Act, DOE has established priorities for carrying out remedial actions at each site (44 FR 74892), relying primarily on advice from EPA. EPA recommended that the primary basis for establishing priorities for carrying out remedial action should be the estimated near-term local rates of induction of health effects associated with radon emissions from the piles. Accordingly, DOE established 9 sites as having "high" priority, 6 as having "medium" priority, and 9 as having "low" priority for carrying out remedial actions. However, in advising DOE on a logical order for carrying out remedial actions, EPA noted that it was not addressing the need for nor the goals of such actions (see docket item IV-E-2).

EPA's goals for control of these tailings piles were described in the supporting documents (see below) for the final standards as: isolation and stabilization against misuse by people and dispersal by natural forces; reduction of risk to nearby individuals and of the collective risk to populations from radon emitted by the piles; elimination of any significant exposure to gamma radiation from piles; and protection of ground and surface water quality. The longevity of control to achieve these goals was a major concern in setting the standards.

Issues for Public Comment

During the review of the standards by certain Federal agencies required by Section 206(a) of the Act and Executive Order 12291 (46 FR 13193-8, February 19, 1981), questions were raised regarding the appropriateness of the control standards for general application to all 24 inactive sites. Noting that the regions around "low" priority sites are generally sparsely populated, some reviewers suggested that less restrictive standards might be appropriate for sites in the lower priority categories than for those having "high" priority for carrying out remedial actions. In view of this concern at Federal agencies that have reviewed the final standards, EPA is requesting public comments on this issue.

Some of these Federal reviewers suggested, in addition, that a radon limit applied at the boundary ("fenceline") of the government-owned property around a tailings pile would be an appropriate form of standards for the lower priority sites. Such a standard could be satisfied largely by institutional methods, i.e., by acquiring and maintaining control over land. The standard of Subpart A, however, can be satisfied only by generally more costly physical methods (such as applying thick earthen covers) that control the tailings and their emissions, with minimal reliance on institutional methods. EPA also requests comments on the adequacy of such a radon "fenceline" standard to meet the objectives of the Act.

Comments on both issues are requested to assist the Agency in its decision whether the standards should be revised for the lower priority sites. Revision of the standards is authorized by Section 275a of the Atomic Energy Act, as added by Pub. L. 95-604. Persons interested in commenting on these issues may wish to examine the rulemaking record (see "ADDRESS," above), or review site-specific information. Of special interest are the Preamble to the final standards published today, and the Final Environmental Impact Statement (EPA Report 520/4-82-013-1; instructions for obtaining this report are given in the

Preamble). Individual "Engineering Assessment" reports have been prepared for DOE for the 24 designated sites. Ordering instructions may be obtained from the U.S. Department of Energy, Albuquerque Operations Office, Uranium Mill Tailings Remedial Action Project Office, Albuquerque, New Mexico 87108; telephone number 505-844-1014.

List of Subjects in 40 CFR Part 192

Environmental protection, Radiation protection, Uranium.

Dated: December 27, 1982.

John W. Hernandez, Jr.,

Acting Administrator.

[FR Doc. 82-35506 Filed 12-30-82; 11:00 am]

BILLING CODE 6560-50-M

Consideration of Inadvertent Human Intrusion into Geologic Repositories. The most speculative potential disruptions of a mined geologic repository are those associated with inadvertent human intrusion. Some types of intrusion would have virtually no effect on a repository's containment of waste. On the other hand, it is possible to conceive of intrusions (involving widespread societal loss of knowledge regarding radioactive wastes) that could result in major disruptions that no reasonable repository selection or design precautions could alleviate. The Agency believes that the most productive consideration of inadvertent intrusion concerns those realistic possibilities that may be usefully mitigated by repository design, site selection, or use of passive controls (although passive institutional controls should not be assumed to completely rule out the possibility of intrusion). Therefore, inadvertent and intermittent intrusion by exploratory drilling for resources (other than any provided by the disposal system itself) can be the most severe intrusion scenario assumed by the implementing agencies. Furthermore, the implementing agencies can assume that passive institutional controls or the intruders' own exploratory procedures are adequate for the intruders to soon detect, or be warned of, the incompatibility of the area with their activities.

Frequency and Severity of Inadvertent Human Intrusion into Geologic Repositories. The implementing agencies should consider the effects of each particular disposal system's site, design, and passive institutional controls in judging the likelihood and consequences of such inadvertent exploratory drilling. However, the Agency assumes that the likelihood of such inadvertent and intermittent drilling need not be taken to be greater than 30 boreholes per square kilometer of repository area per 10,000 years for geologic repositories in proximity to sedimentary rock formations, or more than 3 boreholes per square kilometer per 10,000 years for repositories in other geologic formations. Furthermore, the Agency assumes that the consequences of such inadvertent drilling need not be assumed to be more severe than: (1) Direct release to the land surface of all the ground water in the repository horizon that would promptly flow through the newly created borehole to the surface due to natural lithostatic pressure—or (if pumping would be required to raise water to the surface) release of 200 cubic meters of ground water pumped to the surface if that much water is readily available to be pumped; and (2) creation of a ground water flow path with a permeability typical of a borehole filled by the soil or gravel that would normally settle into an open hole over time—not the permeability of a carefully sealed borehole.

PART 192—HEALTH AND ENVIRONMENTAL PROTECTION STANDARDS FOR URANIUM AND THORIUM MILL TAILINGS

AUTHORITY: Sec. 275 of the Atomic Energy Act of 1954, 42 U.S.C. 2022, as added by the Uranium Mill Tailings Radiation Control Act of 1978, Pub. L. 95-604, as amended.

SOURCE: 48 FR 602, Jan. 5, 1983, unless otherwise noted.

Subpart A—Standards for the Control of Residual Radioactive Materials from Inactive Uranium Processing Sites

§ 192.00 Applicability.

This subpart applies to the control of residual radioactive material at designated processing or depository sites under section 108 of the Uranium Mill Tailings Radiation Control Act of 1978 (henceforth designated "the Act"), and to restoration of such sites following any use of subsurface minerals under section 104(h) of the Act.

§ 192.01 Definitions.

(a) Unless otherwise indicated in this subpart, all terms shall have the same meaning as in Title I of the Act.

(b) *Remedial* action means any action performed under section 108 of the Act.

(c) *Control* means any remedial action intended to stabilize, inhibit future misuse of, or reduce emissions or effluents from residual radioactive materials.

(d) *Disposal site* means the region within the smallest perimeter of residual radioactive material (excluding cover materials) following completion of control activities.

(e) *Depository site* means a disposal site (other than a processing site) selected under section 104(b) or 105(b) of the Act.

(f) *Curie* (Ci) means the amount of radioactive material that produces 37 billion nuclear transformation per second. One picocurie (pCi) = 10^{-12}Ci.

§ 192.02 Standards.

Control shall be designed[1] to:

(a) Be effective for up to one thousand years, to the extent reasonably achievable, and, in any case, for at least 200 years, and,

(b) Provide reasonable assurance that releases of radon-222 from residual radioactive material to the atmosphere will not:

(1) Exceed an average[2] release rate of 20 picocuries per square meter per second, *or*

(2) Increase the annual average concentration of radon-222 in air at or above any location outside the disposal site by more than one-half picocurie per liter.

[1] Because the standard applies to design, monitoring after disposal is not required to demonstrate compliance.

Subpart B—Standards for Cleanup of Land and Buildings Contaminated with Residual Radioactive Materials from Inactive Uranium Processing Sites

§ 192.10 Applicability.

This subpart applies to land and buildings that are part of any processing site designated by the Secretary of Energy under section 102 of the Act. section 101 of the Act, states, in part, that "processing site" means—

(a) Any site, including the mill, containing residual radioactive materials at which all or substantially all of the uranium was produced for sale to any Federal agency prior to January 1, 1971, under a contract with any Federal agency, except in the case of a site at or near Slick Rock, Colorado, unless—

(1) Such site was owned or controlled as of Januray 1, 1978, or is thereafter owned or controlled, by any Federal agency, or

(2) A license (issued by the (Nuclear Regulatory) Commission or its predecessor agency under the Atomic Energy Act of 1954 or by a State as permitted under section 274 of such Act) for the production at site of any uranium or thorium product derived from ores is in effect on January 1, 1978, or is issued or renewed after such date; and

[2] This average shall apply over the entire surface of the disposal site and over at least a one-year period. Radon will come from both residual radioactive materials and from materials covering them. Radon emissions from the covering materials should be estimated as part of developing a remedial action plan for each site. The standard, however, applies only to emissions from residual radioactive materials to the atmosphere.

(b) Any other real property or improvement thereon which—

(1) Is in the vicinity of such site, and

(2) Is determined by the Secretary, in consultation with the Commission, to be contaminated with residual radioactive materials derived from such site.

§ 192.11 Definitions.

(a) Unless otherwise indicated in this subpart, all terms shall have the same meaning as defined in Title I of the Act or in Subpart A.

(b) "Land" means any surface or subsurface land that is not part of a disposal site and is not covered by an occupiable building.

(c) "Working Level" (WL) means any combination of short-lived radon decay products in one liter of air that will result in the ultimate emission of alpha particles with a total energy of 130 billion electron volts.

(d) "Soil" means all unconsolidated materials normally found on or near the surface of the earth including, but not limited to, silts, clays, sands, gravel, and small rocks.

§ 192.12 Standards.

Remedial actions shall be conducted so as to provide reasonable assurance that, *as a result of residual radioactive materials from any designated processing site:*

(a) The concentration of radium-226 in land averaged over any area of 100 square meters shall not exceed the background level by more than—

(1) 5 pCi/g, averaged over the first 15 cm of soil below the surface, and

(2) 15 pCi/g, averaged over 15 cm thick layers of soil more than 15 cm below the surface.

(b) In any occupied or habitable building—

(1) The objective of remedial action shall be, and reasonable effort shall be made to achieve, an annual average (or equivalent) radon decay product concentration (including background) not to exceed 0.02 WL. In any case, the radon decay product concentration (including background) shall not exceed 0.03 WL, and

(2) The level of gamma radiation shall not exceed the background level by more than 20 microroentgens per hour.

Subpart C—Implementation

§ 192.20 Guidance for implementation.

Section 108 of the Act requires the Secretary of Energy to select and perform remedial actions with the concurrence of the Nuclear Regulatory Commission and the full participation of any State that pays part of the cost, and in consultation, as appropriate, with affected Indian Tribes and the Secretary of the Interior. These parties, in their respective roles under section 108, are referred to hereafter as "the implementing agencies." The implementing agencies shall establish methods and procedures to provide "reasonable assurance" that the provisions of Subparts A and B are satisfied. This should be done as appropriate through use of analytic models and site-specific analyses, in the case of Subpart A, and for Subpart B through measurements performed within the accuracy of currently available types of field and laboratory instruments in conjunction with reasonable survey and sampling procedures. These methods and procedures may be varied to suit conditions at specific sites. In particular:

(a)(1) The purpose of Subpart A is to provide for long-term stabilization and isolation in order to inhibit misuse and spreading of residual radioactive materials, control releases of radon to air, and protect water. Subpart A may be implemented through analysis of the physical properties of the site and the control system and projection of the effects of natural processes over time. Events and processes that could significantly affect the average radon release rate from the entire disposal site should be considered. Phenomena that are localized or temporary, such as local cracking or burrowing of rodents, need to be taken into account only if their cumulative effect would be significant in determining compliance with the standard. Computational models, theories, and prevalent expert judgment may be used to decide that a control system design will satisfy the standard. The numerical range provided in the standard for the longevity of the effectiveness of the control of residual radioactive materials allows for consideration of the various factors affecting the longevity of control and stabilization methods and their costs. These factors have different levels of predictability and may vary for the different sites.

(2) Protection of water should be considered in the analysis for reasonable assurance of compliance with the provisions of § 192.02. Protection of water should be considered on a case-specific basis, drawing on hydrological and geochemical surveys and all other relevant data. The hydrologic and geologic assessment to be conducted at each site should include a monitoring program sufficient to establish background ground water quality through one or more upgradient wells, and identify the presence and movement of plumes associated with the tailings piles.

(3) If contaminants have been released from a tailings pile, an assessment of the location of the contaminants and the rate and direction of movement of contaminated ground water, as well as its relative contamination, should be made. In addition, the assessment should identify the attenuative capacity of the unsaturated and saturated zone to determine the extent of plume movement. Judgments on the possible need for remedial or protective actions for groundwater aquifers should be guided by relevant considerations described in EPA's hazardous waste management system (47 FR 32274, July 26, 1982) and by relevant State and Federal Water Quality Criteria for anticipated or existing uses of water over the term of the stabilization. The decision on whether to institute remedial action, what specific action to take, and to what levels an aquifer should be protected or restored should be made on a case-by-case basis taking into account such factors as technical feasibility of improving the aquifer in its hydrogeologic setting, the cost of applicable restorative or protective programs, the present and future value of the aquifer as a water resource, the availability of alternative water supplies, and the degree to which human exposure is likely to occur.

(b)(1) Compliance with Subpart B, to the extent practical, should be demonstrated through radiation surveys. Such surveys may, if appropriate, be restricted to locations likely to contain residual radioactive materials. These surveys should be designed to provide for compliance averaged over limited areas rather than point-by-point compliance with the standards. In most cases, measurement of gamma radiation exposure rates above and below the land surface can be used to show compliance with § 192.12(a). Protocols for making such measurements should be based on realistic radium distributions near the surface rather than extremes rarely encountered.

(2) In § 192.12(a), "background level" refers to the native radium concentration in soil. Since this may not be determinable in the presence of contamination by residual radioactive materials, a surrogate "background level" may be established by simple direct or indirect (e.g., gamma radiation) measurements performed nearby but outside of the contaminated location.

(3) Compliance with § 192.12(b) may be demonstrated by methods that the Department of Energy has approved for use under Pub. L. 92-314 (10 CFR Part 712), or by other methods that the implementing agencies determine are adequate. Residual radioactive materials should be removed from buildings exceeding 0.03 WL so that future replacement buildings will not pose a hazard [unless removal is not practical—see § 192.21(c)]. However, sealants, filtration, and ventilation devices may provide reasonable assurance of reductions from 0.03 WL to below 0.02 WL. In unusual cases, indoor radiation may exceed the levels specified in § 192.12(b) due to sources other than residual radioactive materials. Remedial actions are not required in order to comply with the standard when there is reasonable assurance that residual radioactive materials are not the cause of such an excess.

§ 192.21 Criteria for applying supplemental standards.

The implementing agencies may (and in the case of subsection (f) shall) apply standards under § 192.22 in lieu of the standards of Subpart A or B if they determine that any of the following circumstances exists:

(a) Remedial actions required to satisfy Subpart A or B would pose a clear and present risk of injury to workers or to members of the public, notwithstanding reasonable measures to avoid or reduce risk.

(b) Remedial actions to satisfy the cleanup standards for land, § 192.12(a), or the acquisition of minimum materials required for control to satisfy § 192.02(b), would, notwithstanding reasonable measures to limit damage, directly produce environmental harm that is clearly excessive compared to the health benefits to persons living on or near the site, now or in the future. A clear excess of environmental harm is harm that is long-term, manifest, and grossly disproportionate to health benefits that may reasonably be anticipated.

(c) The estimated cost of remedial action to satisfy § 192.12(a) at a "vicinity" site (described under section 101(6)(B) of the Act) is unreasonably high relative to the long-term benefits, and the residual radioactive materials do not pose a clear present or future hazard. The likelihood that buildings will be erected or that people will spend long periods of time at such a vicinity site should be considered in evaluating this hazard. Remedial action will generally not be necessary where residual radioactive materials have been placed semi-permanently in a location where site-specific factors limit their hazard and from which they are costly or difficult to remove, or where only minor quantities of residual radioactive materials are involved. Examples are residual radioactive materials under hard surface public roads and sidewalks, around public sewer lines, or in fence post foundations. Supplemental standards should not be applied at such sites, however, if individuals are likely to be exposed for long periods of time to radiation from such materials at levels above those that would prevail under § 192.12(a).

(d) The cost of a remedial action for cleanup of a building under § 192.12(b) is clearly unreasonably high relative to the benefits. Factors that should be included in this judgment are the anticipated period of occupancy, the incremental radiation level that would be affected by the remedial action, the residual useful lifetime of the building, the potential for future construction at the site, and the applicability of less costly remedial methods than removal of residual radioactive materials.

(e) There is no known remedial action.

(f) Radionuclides other than radium-226 and its decay products are present in sufficient quantity and concentration to constitute a significant radiation hazard from residual radioactive materials.

§ 192.22 Supplemental standards.

Federal agencies implementing Subparts A and B may in lieu thereof proceed pursuant to this section with respect to generic or individual situations meeting the eligibility requirements of § 192.21.

(a) When one or more of the criteria of § 192.21(a) through (e) applies, the implementing agencies shall select and perform remedial actions that come as close to meeting the otherwise applicable standard as is reasonable under the circumstances.

(b) When § 192.21(f) applies, remedial actions shall, in addition to satisfying the standards of Subparts A and B, reduce other residual radioactivity to levels that are as low as is reasonably achievable.

(c) The implementing agencies may make general determinations concerning remedial actions under this section that will apply to all locations with specified characteristics, or they may make a determination for a specific location. When remedial actions are proposed under this section for a specific location, the Department of Energy shall inform any private owners and occupants of the affected location and solicit their comments. The Department of Energy shall provide any such comments to the other implementing agencies. The Department of Energy shall also periodically inform the Environmental Protection Agency of both general and individual determinations under the provisions of this section.

§ 192.23 Effective date.

Subparts A, B, and C shall be effective March 7, 1983.

Subpart D—Standards for Management of Uranium Byproduct Materials Pursuant to Section 84 of the Atomic Energy Act of 1954, as Amended

SOURCE: 48 FR 45946, Oct. 7, 1983, unless otherwise noted.

§ 192.30 Applicability.

This subpart applies to the management of uranium byproduct materials under section 84 of the Atomic Energy Act of 1954 (henceforth designated "the Act"), as amended, during and following processing of uranium ores, and to restoration of disposal sites following any use of such sites under section 83(b)(1)(B) of the Act.

§ 192.31 Definitions and cross-references.

References in this subpart to other parts of the Code of Federal Regulations are to those parts as codified on January 1, 1983.

(a) Unless otherwise indicated in this subpart, all terms shall have the same meaning as in Title II of the Uranium Mill Tailings Rediation Control Act of 1978, Subparts A and B of this part, or Parts 190, 260, 261, and 264 of this chapter. For the purposes of this subpart, the terms "waste," "hazardous waste," and related terms, as used in Parts 260, 261, and 264 of this chapter shall apply to byproduct material.

(b) *Uranium byproduct material* means the tailings or wastes produced by the extraction or concentration of uranium from any ore processed primarily for its source material content. Ore bodies depleted by uranium solution extraction operations and which remain underground do not constitute "byproduct material" for the purpose of this subpart.

(c) *Control* means any action to stabilize, inhibit future misuse of, or reduce emissions or effluents from uranium byproduct materials.

(d) *Licensed site* means the area contained within the boundary of a location under the control of persons generating or storing uranium byproduct materials under a license issued pursuant to section 84 of the Act. For purposes of this subpart, "licensed site" is equivalent to "regulated unit" in Subpart F of Part 264 of this chapter.

(e) *Disposal site* means a site selected pursuant to section 83 of the Act.

(f) *Disposal area* means the region within the perimeter of an impoundment or pile containing uranium by product materials to which the post-closure requirements of § 192.32(b)(1) of this subpart apply.

(g) *Regulatory agency* means the U.S. Nuclear Regulatory Commission.

(h) *Closure period* means the period of time beginning with the cessation, with respect to a waste impoundment, of uranium ore processing operations and ending with completion of requirements specified under a closure plan.

(i) *Closure plan* means the plan required under § 264.112 of this chapter.

(j) *Existing portion* means that land surface area of an existing surface impoundment on which significant quantities of uranium byproduct materials have been placed prior to promulgation of this standard.

§ 192.32 Standards.

(a) *Standards for application during processing operations and prior to the end of the closure period.* (1) Surface impoundments (except for an existing portion) subject to this subpart must be designed, constructed, and installed in such manner as to conform to the requirements of § 264.221 of this chapter, except that at sites where the annual precipitation falling on the impoundment and any drainage area contributing surface runoff to the impoundment is less than the annual evaporation from the impoundment, the requirements of § 264.228(a)(2)(iii)(E) referenced in § 264.221 do not apply.

(2) Uranium byproduct materials shall be managed so as to conform to the ground water protection standard

MSD 000553

in § 264.92 of this chapter, except that for the purposes of this subpart:

(i) To the list of hazardous constituents referenced in § 264.93 of this chapter are added the chemical elements molybdenum and uranium,

(ii) To the concentration limits provided in Table 1 of § 264.94 of this chapter are added the radioactivity limits in Table A of this subpart,

(iii) Detection monitoring programs required under § 264.98 to establish the standards required under § 264.92 shall be completed within one (1) year of promulgation,

(iv) The regulatory agency may establish alternate concentration limits (to be satisfied at the point of compliance specified under § 264.95) under the criteria of § 264.94(b), provided that, after considering practicable corrective actions, these limits are as low as reasonably achievable, and that, in any case, the standards of § 264.94(a) are satisfied at all points at a greater distance than 500 meters from the edge of the disposal area and/or outside the site boundary, and

(v) The functions and responsibilities designated in Part 264 of this chapter as those of the "Regional Administrator" with respect to "facility permits" shall be carried out by the regulatory agency, except that exemptions of hazardous constituents under § 264.93 (b) and (c) of this chapter and alternate concentration limits established under § 264.94 (b) and (c) of this chapter (except as otherwise provided in § 192.32(a)(2)(iv)) shall not be effective until EPA has concurred therein.

(3) Uranium byproduct materials shall be managed so as to conform to the provisions of:

(i) Part 190 of this chapter, "Environmental Radiation Protection Standards for Nuclear Power Operations" and

(ii) Part 440 of this chapter, "Ore Mining and Dressing Point Source Category: Effluent Limitations Guidelines and New Source Performance Standards, Subpart C, Uranium, Radium, and Vanadium Ores Subcategory."

(4) The regulatory agency, in conformity with Federal Radiation Protection Guidance (FR, May 18, 1960, pgs. 4402-4403), shall make every effort to maintain radiation doses from radon emissions from surface impoundments of uranium byproduct materials as far below the Federal Radiation Protection Guides as is practicable at each licensed site.

(b) *Standards for application after the closure period.* At the end of the closure period:

(1) Disposal areas shall each comply with the closure performance standard in § 264.111 of this chapter with respect to nonradiological hazards and shall be designed[1] to provide reasonable assurance of control of radiological hazards to

(i) Be effective for one thousand years, to the extent reasonably achievable, and, in any case, for at least 200 years, and,

(ii) Limit releases of radon-222 from uranium byproduct materials to the atmosphere so as to not exceed an average[2] release rate of 20 picocuries per square meter per second (pCi/m²s).

(2) The requirements of § 192.32(b)(1) shall not apply to any portion of a licensed and/or disposal site which contains a concentration of radium-226 in land, averaged over areas of 100 square meters, which, as a result of uranium byproduct material, does not exceed the background level by more than:

(i) 5 picocuries per gram (pCi/g), averaged over the first 15 centimeters (cm) below the surface, and

(ii) 15 pCi/g, averaged over 15 cm thick layers more than 15 cm below the surface.

§ 192.33 Corrective action programs.

If the ground water standards established under provisions of § 192.32(a)(2) are exceeded at any licensed site, a corrective action program as specified in § 264.100 of this chapter shall be put into operation as soon as is practicable, and in no event later than eighteen (18) months after a finding of exceedance.

§ 192.34 Effective date.

Subpart D shall be effective December 6, 1983.

TABLE A TO SUBPART D

	pCi/liter
Combined radium-226 and radium-228	5
Gross alpha-particle activity (excluding radon and uranium)	15

Subpart E—Standards for Management of Thorium Byproduct Materials Pursuant to Section 84 of the Atomic Energy Act of 1954, as Amended

SOURCE: 48 FR 45947, Oct. 7, 1983, unless otherwise noted.

§ 192.40 Applicability.

This subpart applies to the management of thorium byproduct materials under section 84 of the Atomic Energy Act of 1954, as amended, during and following processing of thorium ores, and to restoration of disposal sites following any use of such sites under section 83(b)(1)(B) of the Act.

§ 192.41 Provisions.

The provisions of Subpart D of this part, including §§ 192.31, 192.32, and 192.33, shall apply to thorium byproduct material and:

(a) Provisions applicable to the element uranium shall also apply to the element thorium;

(b) Provisions applicable to radon-222 shall also apply to radon-220; and

(c) Provisions applicable to radium-226 shall also apply to radium-228.

(d) Operations covered under § 192.32(a) shall be conducted in such a manner as to provide reasonable assurance that the annual dose equivalent does not exceed 25 millirems to the whole body, 75 millirems to the thyroid, and 25 millirems to any other organ of any member of the public as a result of exposures to the planned discharge of radioactive materials, radon-220 and its daughters excepted, to the general environment.

§ 192.42 Substitute provisions.

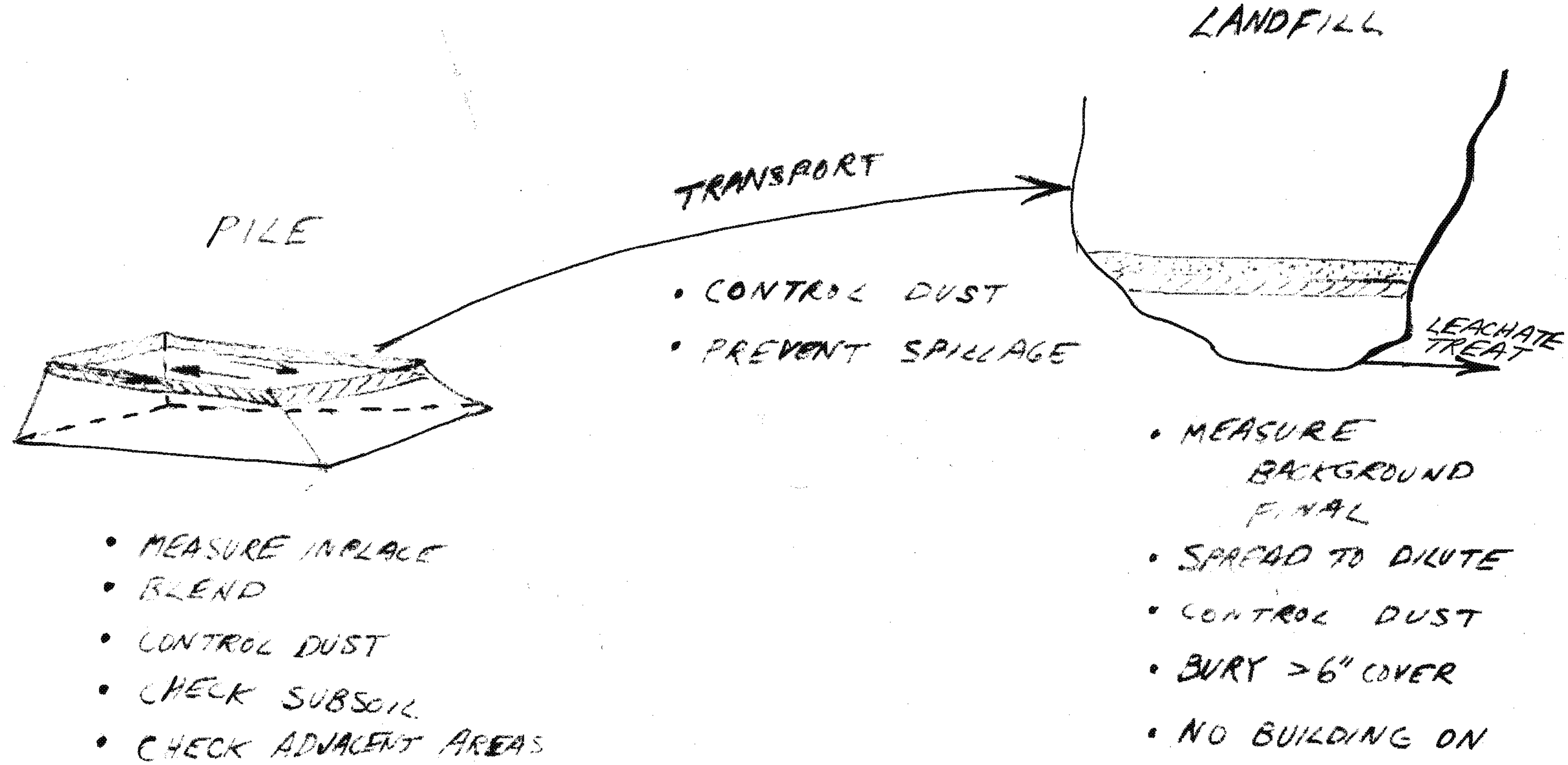
The regulatory agency may, with the concurrence of EPA, substitute for any provisions of § 192.41 of this subpart alternative provisions it deems more practical that will provide at least an equivalent level of protection for human health and the environment.

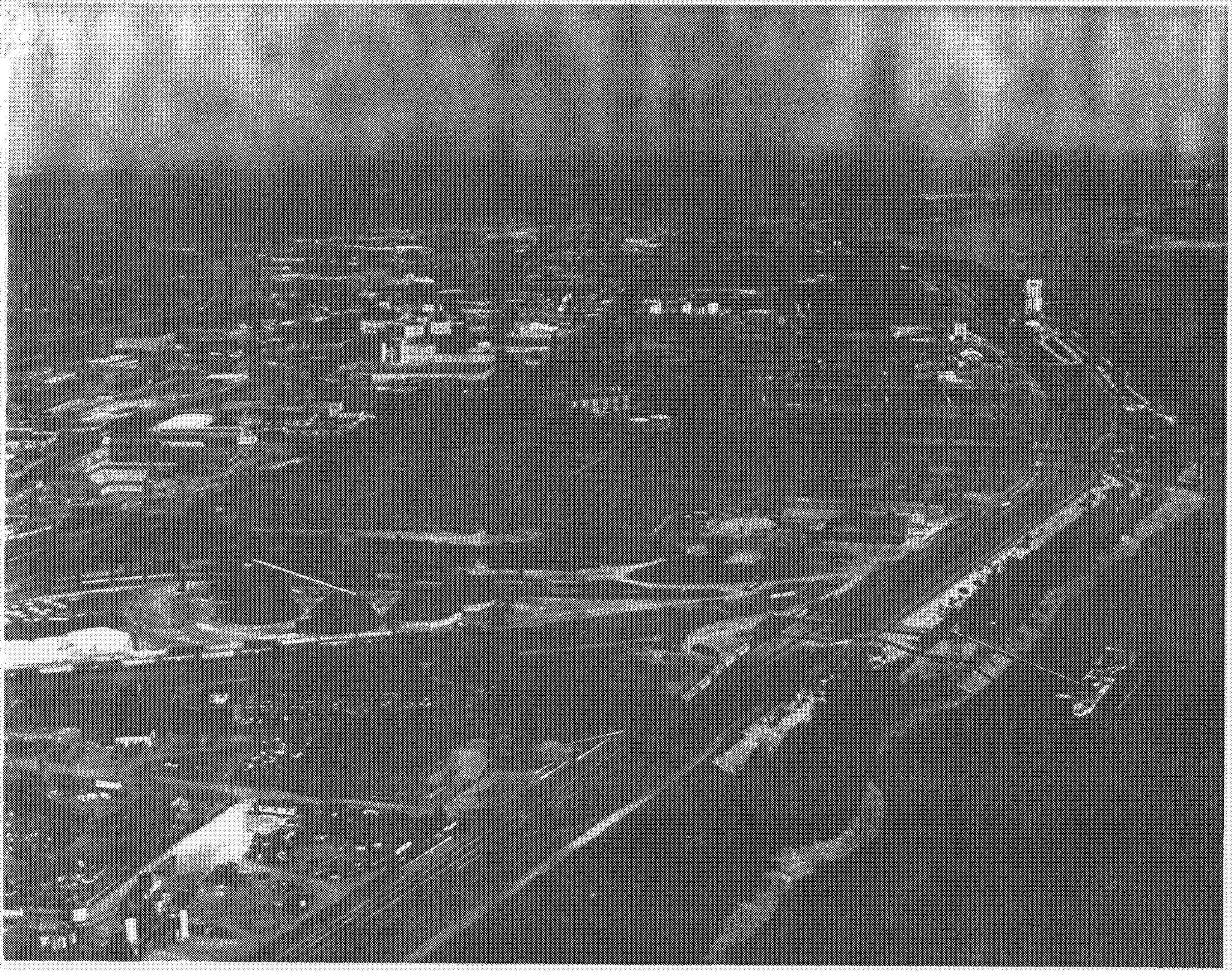
§ 192.43 Effective date.

Subpart E shall be effective December 6, 1983.

[1] The standard applies to design. Monitoring for radon-222 after installation of an appropriately designed cover is not required.

[2] This average shall apply to the entire surface of each disposal area over periods of at least one year, but short compared to 100 years. Radon will come from both uranium byproduct materials and from covering materials. Radon emissions from covering materials should be estimated as part of developing a closure plan for each site. The standard, however, applies only to emissions from uranium byproduct materials to the atmosphere.


LANDFILL
TRANSPORT
PILE
• CONTROL DUST
• PREVENT SPILLAGE
LEACHATE TREAT
• MEASURE
BACKGROUND
FINAL
• SPREAD TO DILUTE
• CONTROL DUST
• BURY > 6" COVER
• NO BUILDING ON
• MEASURE INPLACE
• BLEND
• CONTROL DUST
• CHECK SUBSOIL
• CHECK ADJACENT AREAS



LANGE-STEGMANN FERTILIZER CO.
1 Angelica Street
ST. LOUIS, MISSOURI 63147

PRODUCT LIST - FOR READY REFERENCE

PRODUCT NAME	ANALYSIS
Ammonium Nitrate	34-0-0
Ammonium Sulfate (Granular & Fine)	21-0-0-24S
Anhydrous Ammonia	82%-N
Bagged - Lange Fertilizers	Various
Boron	13.7%-B
Calcium Nitrate (15.5%-N 19%-WS Calcium)	-
Diammonium Phosphate (DAP)	18-46-0
Dried Clay	-
Granular Triple Super Phosphate (GTSP)	0-46-0
Granular Urea	46-0-0
Iron	40%-Fe
K-Mag (Granular & Turf Grade)	-
Lawn Man Family of Products	Various
Magnesium	36%-Mg
Manganese	28%-Mn
Melt Man Ice Melter (10# - 20# - 50#)	-
Micro-Prilled Urea (For Melt-Down)	46%-N
Min-U-Gel Suspension Clay (100 & 200)	-
Mixed Grade Bulk - Lange Fertilizers	Various
Monoammonium Phosphate (MAP)	11-52-0
Muriate of Potash (Granular & Coarse)	0-0-60
Muriate of Potash (Soluble)	0-0-62.4
Nitrogen Solution (28%-N 32%-N)	-
Potassium Nitrate (Soluble)	13-0-44
Prilled Urea	46-0-0
Single Super Phosphate	0-18-0
Specialty Products	Various
Sul-Po-Mag (22%-K 18%-MgO 22%-S)	-
Sulfate of Potash 12%-S (Gran. & Standard)	0-0-50
Sulfate of Potash (Soluble)	0-0-50
Sulfur (Elemental)	90%-S
Sulfur Coated Urea (S.C.U.)	37-0-0-15S
Urea-Formaldehyde (Lg/Sm Granular & Powder)	38-0-0
Zinc	36%-Zn
Zinc Sulfate (36%-ZN 17.5%-S)	-

CUSTOM BLENDING AND BAGGING FOR SPECIAL ANALYSIS

BAG OR BULK DELIVERY AVAILABLE

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January 9, 1981

Mr. Bernard A. Rains,
Manager, Industrial Pollution Control
Metropolitan St. Louis Sewer District
10 East Grand
St. Louis, Mo. 63147

Dear Bernie:

Enclosed are regulations of the Division of Health and excerpts from the Missouri statutes giving the Division of Health authority over certain types of radiation control.

Sincerely,

Noble

Noble Robinson,
Director, Environmental Affairs

/bd
enc.

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MSD 000558

Rules of
Department of Social Services
Division 50—Division of Health
Chapter 90—Protection Against Ionizing Radiation

Title 13—DEPARTMENT OF SOCIAL SERVICES
Division 50—Division of Health
Chapter 90—Protection Against Ionizing Radiation

13 CSR 50-90.010 Definitions

PURPOSE: The purpose of this rule is to define technical terms which are used throughout this chapter.

(1) Absorbed dose of any ionizing radiation is the energy imparted to matter by ionizing particles per unit mass of irradiated material at the place of interest. The unit of absorbed dose is the rad.

(2) Aluminum equivalent is the thickness of aluminum affording the same attenuation, under specified conditions, as the material in question.

(3) Controlled area is an area in which the occupational exposure of personnel to radiation or to radioactive material is under the supervision of an individual in charge of radiation protection. (This means that a controlled area is one that requires control of access, occupancy, and working conditions for radiation protection purposes)

(4) Dead-man switch is a switch so constructed that a circuit closing contact can only be maintained by continuous pressure by the operator.

(5) Division is the Division of Health of the Department of Social Services, State of Missouri.

(6) Dose, unless otherwise indicated, as used in these regulations, means REM dose.

(7) Effective half-life (T), in days, is:

$$T = \frac{(Tb) \times (Tr)}{(T_b) + (T_r)}$$

where T_b: biological half-life in days

and T_r: physical half-life in days

(8) Execessive radiation dose is a dose of radiation in excess of maximum permissible dose. (13 CSR 50-90.040).

(9) Individual is any human being.

(10) Installation is a place containing one or more sources of radiation.

(11) Lead equivalent is the thickness of lead affording the same attenuation, under specified conditions, as the material in question.

(12) Maximum permissible accumulated dose (MPAD) is the dose of radiation which, if accumulated during the lifetime of the individual, is not expected to cause observable bodily injury.

(13) Maximum permissible dose (MPD) is the maximum (REM) dose that the body of an individual or specific parts thereof shall be permitted to receive in a stated period of time.

(14) Person is any individual, partnership, association, corporation, firm, trust, estate, public or private institution, group, agency, political subdivision of this state, and any legal successor, representative, agent, or agency of the foregoing.

(15) Personnel monitoring is the determination of the radiation dose received by an individual during the specified period.

(16) Protective barrier is a barrier of attenuating materials used to reduce radiation exposure.

(17) Qualified expert is an individual fitted by training and experience to perform dependable radiation surveys, to oversee radiation monitoring, and to estimate the degree of radiation hazard. If the ability of a qualified expert is questioned, the division shall be the judge of his qualifications, in regard to which it may consider the testimony of other persons whom it deems expert.

(18) Rad is the unit of absorbed dose and is equal to 100 ergs per gram. It is a measure of the energy imparted to matter by ionizing particles per unit mass of irradiated material at the place of interest.

(19) Radiation is gamma rays and X-rays, alpha and beta particles, high-speed electrons, neutrons, protons, other nuclear particles and any other ionizing

radiation; but not sound or radio waves, or visible, infrared, or ultraviolet light.

(20) Radiation hazard is any condition that might result in the exposure of individuals to excessive radiation dose.

(21) Radiation machine is any device that produces radiation when in operation.

(22) Radioactive material is any material, solid, liquid, or gas, that emits radiation spontaneously.

(23) Relative biological effectiveness, (RBE) is a numerical factor which is used to compare the effectiveness of absorbed dose of radiation delivered in different ways. The standard of comparison is X- or gamma radiation having a linear energy transfer in water of 3 kev per micron. A list of RBE values of various kinds of radiation is given in Table 1, 13 CSR 50-90.110.

(24) Rem is equal to the absorbed dose in rads multiplied by the appropriate RBE.

(25) Roentgen is a unit of exposure dose of X-ray or gamma radiation such that the associated corpuscular emission per 0.001293 gram of air produces, in air, ions carrying 1 esu of quantity of electricity.

(26) Sealed source is a quantity of radioactive material so enclosed as to prevent the escape of any radioactive material.

(27) Source (of radiation) is a radiation machine or a quantity of radioactive materials.

(28) Survey is the evaluation of actual or potential radiation or contamination hazards by or under the supervision of a qualified expert.

(29) X-ray tube housing protective diagnostic-type is one that reduces the leakage radiation to a maximum of 0.10 roentgen in one hour at a distance of one meter from the tube target when the X-ray tube is operating at its maximum current and voltage.

(30) X-ray tube housing protective therapeutic-type is a tube housing so constructed that the leakage radiation at a distance of one meter from the target cannot exceed the rate of one roentgen per hour and at a distance of five centimeters from any point on the surface of the housing accessible to the patient cannot exceed the rate of 30 roentgens per hour when the tube is operated at its maximum current and voltage.

(31) Useful beam is that part of radiation which passes through the window, aperture, cone, or collimating device of the tube housing.

(32) User is a person having administrative control over one or more sources.

(33) Other scientific and technical terms not herein specifically defined shall be used in accordance with the definitions in recommendations of the National Committee on Radiation Protection and Measurements as published in Handbooks of the National Bureau of Standards, or The American Standard Association's "Glossary of Terms in Nuclear Science and Technology," with preference being in the order given.

Auth: section 192.420 RSMo (1969). Original rule filed Nov. 9, 1964, effective Dec. 9, 1964.

13 CSR 50-90.020 Exemptions

PURPOSE: This rule lists exemptions from the requirements of this chapter. Its purpose is to avoid unnecessary regulation and duplication of regulatory authority.

(1) The following materials, machines and conditions are exempt from the requirements of this chapter:

(A) Timepieces, instruments, novelties, or devices containing self-luminous elements themselves. Such timepieces, instruments, novelties, or devices shall not be exempt if they are stored, used, or handled in such quantity or fashion that an individual might receive a radiation dose exceeding the limits established in 13 CSR 50-90.040.

(B) Electrical equipment that produces radiation incidental to its operation for other purposes, providing the dose rate to the whole body at the point of nearest approach to such equipment when any external shielding is removed does not exceed 0.5 rem per year. The production testing or factory servicing of such equipment shall not be exempt.

(C) Radiation machines which cannot be used in such manner as to produce radiation. (For example, X-ray machines or electrical equipment in storage or transport).

(D) Radioactive material being transported across a state in conformance with regulations of any federal agency having jurisdiction over safety in interstate transport.

(E) The use of radioactive sources licensed by the U. S. Nuclear Regulatory Commission to installations in the state of Missouri.

(F) Other sources of radiation that the division finds should be exempted as approved by the Committee on Radiation Control.

Auth: section 192.420 RSMo (1969). Original rule filed Nov. 9, 1964, effective Dec. 9, 1964.

13 CSR 50-90.030 Registration

PURPOSE: This rule states the conditions under which sources of ionizing radiation must be registered with the division.

(1) The owner, user or operator of every existing not exempted source shall register such source of radiation with the division within 90 days after the effective date of this rule and once every two years thereafter as long as he continues to possess the source. Any newly acquired source shall be registered with the Division of Health within 30 days after receipt. The registration shall be submitted on a form available from the division, and shall describe each source, its location and use, and the waste disposal practices, if any. The registration shall also give the name and address of the user or users and the name and address of the qualified expert.

(2) The user shall notify the division in writing within 30 days of any change with respect to his radiation sources which may substantially increase or decrease the potential for personnel exposure.

(3) All non-exempt radiation sources brought into the state of Missouri for temporary use must be registered at least four days before entry. The registration shall indicate the type and amount of the source, the scope of the use, duration of use and the exact locations of the use or storage. The above requirement may be waived at the discretion of the Division of Health if the use is an unexpected occurrence of major consequence demanding immediate use and of which it would not have been possible to have knowledge four days in advance.

(4) An installation registration may be issued, on application, for research institutions, teaching institutions, and certain manufacturing establishments whose radiation conditions are undergoing constant change. Such institutions and manufacturing establishments must maintain an active and effective radiation committee to review and approve all uses of radiation sources. A qualified expert must be retained to make hazard evaluations of all uses of all radiation sources and must be given authority to enforce recommended procedures.

(5) Registration shall not imply the division's approval of the conditions described in the registration.

Auth: section 192.420 RSMo (1969). Original rule filed Nov. 9, 1964, effective Dec. 9, 1964.

13 CSR 50-90.040 Maximum Permissible Exposure Limits

PURPOSE: The purpose of this rule is to establish maximum permissible exposure limits. Maximum permissible doses are established for both external and internal exposures for persons within or outside controlled areas.

(1) Except as provided in subsections (A), (B), and (C) of this section, the maximum permissible dose (MPD) from all external sources of ionizing radiation for persons within a controlled area shall be as listed in Table I.

TABLE I

Part of Body	A Maximum dose permitted in any calendar year	B Maximum dose permitted in any calendar quarter
Whole body, head and trunk, major portion of the bone marrow, gonads, or lens of eye.	5 rems	3 rems
Skin of large body area.	30 rems	10 rems
Hands and forearms, feet and ankles.	75 rems	25 rems

A dose to the whole body, head and trunk, in addition to that listed in Table I, shall be permitted for a calendar year provided that all three of the following conditions are met:

(A) During any calendar quarter, the maximum dose of three rems, listed in Column B of table I, is not exceeded; and

(B) The user has determined the individual's previous accumulated occupational dose, and

(C) The dose, when added to the previously accumulated occupational dose, does not exceed the maximum permissible accumulated dose (MPAD) calculated according to the formula: MPAD = (N-

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18) x 5 rems, where N is the individual's age in full years.

(2) For persons within a controlled area the radiation dose to the tissues of the body from radioactive materials within the body shall be controlled by limiting the average rates at which such materials are taken into the body. Where this intake results from breathing contaminated air, the concentrations of the radionuclides in the air, averaged over any calendar quarter, shall not exceed the concentrations listed in Appendix I, Table 2, Column 1. The values in this table are for a work week of 40 hours. For longer work weeks the values must be adjusted downward accordingly. Where this intake results from the occurrence of radioactive material in drinking water and foodstuffs, the permissible concentrations shall be the same as in section (3) of this rule.

(3) For persons outside a controlled area, the maximum permissible dose to the whole body due to sources within the controlled area or to radioactive materials escaping from the controlled area, shall be 2 millirems in any one hour, 0.1 rem in any 7 consecutive days and 0.5 rem in any year. In meeting this requirement, the user may take reasonable advantage of operational factors such as the amount of time that the radiation is present or that the area is occupied by any one person.

(4) For persons outside a controlled area, the radiation dose to tissues of the body from radioactive materials within the body shall be controlled by limiting the average rates at which such materials are taken into the body. Where this intake results from the occurrence of radioactive materials in the air, drinking water, or foodstuffs, the average concentrations of the radionuclides in the air, or drinking water or foodstuffs, averaged over any calendar quarter, shall not exceed the concentrations listed in Appendix I, Table 2, Columns 2 and 3.

Auth: section 192.420 RSMo (1969). Original rule filed Nov. 9, 1964, effective Dec. 9, 1964.

13 CSR 50-90.050 Personnel Monitoring and Radiation Surveys

PURPOSE: This rule lists requirements for personnel monitoring and radiation surveys. Conditions under which routine monitoring of individuals occupationally exposed to radiation shall not be required are also listed.

(1) The user shall provide for radiation surveys and monitoring sufficient to assure compliance with other rules of this chapter. The radiation survey and monitoring shall be performed by, or under the direction of, a qualified expert using suitable instruments and methods for measuring radiation.

(2) Until an actual radiation survey can be performed, a written statement made by a qualified expert based on his analysis of the situation shall be acceptable as evidence of the absence of radiation hazard in a given area.

(3) Personnel monitoring shall be required for each individual for whom there is any reasonable possibility of receiving a weekly dose of all radiation exceeding 50 millirems, taking into consideration the use of protective gloves, aprons, or other radiation-limiting devices.

(4) Routine monitoring of individuals occupationally exposed to radiation from radiation machines shall not be required if:

(A) A qualified expert has specified the operating conditions under which there is no reasonable chance that any individual will be subjected to a dose of either more than 25 millirems in any 7 consecutive days or more than 325 millirems in any 13 consecutive weeks.

(B) The operating conditions in subsection (A) of this section are made known to all individuals who may be occupationally exposed to the radiation.

(C) The installation continues to operate only under the specified conditions.

(5) Radiation surveys of sealed sources and sealed storage areas shall be made at least semiannually to insure the integrity of the containment. The survey shall be capable of detecting the presence of 0.005 microcurie of removable contamination. If the survey reveals the presence of 0.005 microcurie or more of removable contamination, the user shall immediately withdraw the sealed source from use and shall cause it to be decontaminated and repaired, or disposed of, in accordance with procedures established by a qualified expert.

Auth: section 192.420 RSMo (1969). Original rule filed Nov. 9, 1964, effective Dec. 9, 1964.

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13 CSR 50-90.060 Radiation Exposure Records and Reports

PURPOSE: This rule requires the user of radiation sources to keep records of personnel exposures, radiation measurements, and the receipt and disposal of radioactive materials. It also states the conditions under which personnel exposures and radiation incidents must be reported.

(1) Records of all measurements required by 13 CSR 50-90.050 shall be kept available by the user for inspection by a representative of the division. Personnel monitoring records shall include the Social Security number and date of birth of the individual concerned.

(2) An accurate accounting for all radioactive materials, not specifically exempted by 13 CSR 50-90.020, shall be maintained. Such records shall show the amount of radioactive material received, transferred, decayed in storage, and disposed of, and such other information as may be necessary to account for the difference between the amount of radioactive material received or produced and the amount on hand. The user shall also keep records of the release of radioactive materials to the environs sufficient to demonstrate compliance with other rules of this chapter. Such records shall be maintained and made available for inspection for at least five years after final disposition of such radioactive material.

(3) Upon termination of employment of an individual, the individual and/or division shall, upon request, be supplied with a summary statement of that individual's radiation dose. (The estimated maximum dose shall be stated if no personnel monitoring has been carried out.) This record shall include statements of any circumstances wherein the dose to the employee from any source of radiation exceeded those specified in this chapter. Employee records must be kept available for inspection by the division during the tenure of employment of an employee and for a period of five years thereafter.

(4) When it is known or believed that an accidental dose to a person in the installation may have exceeded two times the amount permitted by applicable sections of 13 CSR 50-90.040, all facts relative to the occurrence shall be reported in detail to the division within 7 days of the discovery thereof, and a copy of the report shall be put in that individual's personnel file. The cause of the overexposure shall immediately be sought out and corrected.

(5) The loss or theft of any source of radiation not exempt from these rules shall be reported immediately to the division by telephone and a written report shall be submitted within 24 hours.

(6) At the request of any employee, each user shall advise such employee annually of the employee's exposure to radiation as shown in records maintained by the user.

(7) Any accident involving either a public or private carrier conveying radioactive material shall be reported immediately to the Division of Health by telephone and a written report shall be submitted within 24 hours.

Auth: section 192.420 RSMo (1969). Original rule filed Nov. 9, 1964, effective Dec. 9, 1964.

13 CSR 50-90.070 Storage of Radioactive Materials

PURPOSE: The purpose of this rule is to require the safe storage of radioactive material.

(1) The user shall see that radioactive materials are kept in a manner that will provide reasonable assurance that, during routine access to a controlled area, no person will be exposed in excess of the limits set forth in 13 CSR 50-90.040. Provisions shall be made to minimize the hazard to emergency workers in the event of fire and in situations where earthquake, flood, and windstorm potentials exist.

(2) The user shall see that vaults or rooms used for storing materials that may emit radioactive gases or airborne particulate matter are ventilated in such a manner that the concentration of the gases or particulate matter in the air does not constitute a radiation hazard.

(3) When there is a reasonable possibility that chemical, radiation, or other action might lead to leakage of radioactive material from a container, the user shall provide a secondary tray or catchment to the container adequate to retain the entire amount of radioactive material.

Auth: section 192.420 RSMo (1969). Original rule filed Nov. 9, 1964, effective Dec. 9, 1964.

13 CSR 50-90.080 Control of Radioactive Contamination

PURPOSE: The purpose of this rule is to limit personnel exposure by requiring the control or removal of radioactive contamination.

(1) The user shall see that all work with radioactive materials is carried out under conditions which will minimize the possibility of spread of radioactive material that could result in the exposure of any person above any limit specified in 13 CSR 50-90.040.

(2) Where the nature of work is such that a person or his clothing may become contaminated with radioactive material, both shall be monitored according to procedures established by a qualified expert. Personal contamination shall be removed according to procedures established by a qualified expert.

(3) Clothing or other material contaminated to a degree which could result in the exposure of any person above any limit specified in 13 CSR 50-90.040 should be retained inside the installation until it can be decontaminated or disposed of according to procedures established by a qualified expert.

Auth: section 192.420 RSMo (1969). Original rule filed Nov. 9, 1964, effective Dec. 9, 1964.

13 CSR 50-90.090 Disposal of Radioactive Wastes

PURPOSE: This rule lists the conditions under which radioactive material may be released into the air or water or may be disposed of by burial in soil or discharge into a sanitary sewer.

(1) No user shall release radioactive material into the air or water in such a manner as to cause exposure of any person above the limits specified in 13 CSR 50-90.040. If several users are discharging radioactive wastes to the same environs, they shall cooperate in limiting the release and shall file with the Division of Health a statement of their agreed pro rata releases.

(2) Every person who receives radioactive waste material for holding and preparation, prior to disposal, shall first obtain a permit from the Division of Health for such holding and preparation.

(3) No owner or user shall dispose of radioactive waste materials by dumping or burial in soil except at sites approved by and registered with the Division of Health.

(4) Radioactive material may be discharged into a sanitary sewer provided that: waste at that time

(A) Such material is readily soluble or dispersible in water; and

(B) The quantity of any radioactive material released into the sewer in any one day, when diluted by the average daily quantity of sewerage released into the sewer by the owner or user, will not result in average concentration exceeding the limits specified in Table 2, Appendix I, and

(C) The gross quantity of all radioactive material so discharged does not exceed one curie per year.

Auth: section 192.420 RSMo (1969). Original rule filed Nov. 9, 1964, effective Dec. 9, 1964.

13 CSR 50-90.100 Radiation Labeling

PURPOSE: The purpose of this rule is to establish requirements for labeling radiation machines, radiation areas, and containers in which radioactive materials are transferred, stored or used, and to list exemptions from posting or labeling requirements.

(1) The user shall indicate the presence of radiation by posting conspicuous signs or labels which bear appropriate wording, as described in sections (5) through (10) of this rule to explain the nature of the hazard.

(2) All such radiation warning signs and labels shall bear the standard symbol for designating any radiation hazard as described in Appendix II.

(3) The use of the standard symbol, signs or labels for any other purpose is expressly prohibited. The symbol, signs and labels and the lettering used with it shall be as large as practical, consistent with size of the equipment or material. The lettering shall not be superimposed on the symbol.

(4) All signs and labels required by this section shall use the conventional radiation colors (magenta or purple and yellow background) and bear a conventional radiation symbol.

(5) All radiation machines shall be clearly labeled as follows: "Caution: Radiation" This Equipment Produces Radiation When Energized. (Labels should be placed on the control panel near the switch which energizes the tube.)

(6) Each area shall be designated as a radiation area and shall be conspicuously posted with a sign or signs bearing a radiation caution symbol and the words "Caution: Radiation Area" if radiation levels exist which could subject an individual, continuously present, to five millirems within any one hour or could result in a dose of 100 millirems in any seven consecutive days.

(7) Each radiation area wherein there exists a radiation level in excess of 100 milliroentgens per hour shall be conspicuously posted with a sign or signs bearing a conventional radiation caution symbol and the words: "Caution: High Radiation Area".

(A) Each high radiation area, except those containing only therapeutic units operating at 60 kvp or below and/or diagnostic units, shall be equipped with an internal control circuit which shall either cause the radiation exposure rate to be reduced to below 100 milliroentgens per hour upon entry of an individual into the area or shall energize a conspicuous visible or audible alarm signal in such a manner that the individual entering and the supervisor of the activity are made aware of the entry. In the case of a temporary high radiation area (30 days or less), a control circuit is not required if a barricade, such as a fence or rope is erected and the required caution signs are posted.

(8) Any room, enclosure or operating area in which airborne radioactive materials exist in excess of the amount as stated in Table 2, Column 3, Appendix I, of this chapter shall be conspicuously posted with a sign or signs bearing a conventional radiation symbol and the words: "Caution: Airborne Radioactivity Area". In the event that respiratory protection is required, the equipment prescribed shall also be conspicuously designated.

(9) Each entrance to an area or to rooms shall be conspicuously posted with a sign or signs bearing a conventional radiation symbol and the words "Caution: Radioactive Material" if the radioactive material used or stored is an amount exceeding ten times the maximum exempted amount as specified in Table 1, Appendix I.

(10) Each container in which radioactive material is transferred, stored or used shall bear a conventional symbol and the words: "Caution: Radioactive Material". Labeling shall not be required if the concentration of radioactive material does not exceed that specified in Table 2, Columns 2 or 3, Appendix I, if the quantity of radioactive material does not exceed that in Table I, Appendix I, or for laboratory containers being used transiently. Where practical, signs required by this section should describe the quantities and kinds of radioactive materials involved.

(11) All areas that are readily accessible but not normally occupied, and where a radiation hazard may exist on a frequent or infrequent basis, shall be suitably restricted and posted with the accepted radiation-hazard label.

(12) All radiation-hazard labels posted shall be removed when the source of radiation is no longer present.

(13) Notwithstanding the provisions of other sections of this rule:

(A) A room or area is not required to be posted with a caution sign because of the presence of a sealed source provided the radiation level twelve inches from the surface of the device does not exceed five milliroentgens per hour and the sealed source is properly labeled in accordance with the requirements of this rule.

(B) Rooms or other areas in hospitals are not required to be posted with caution signs because of the presence of patients containing radioactive material provided that attendant personnel are adequately instructed as to the precautions necessary to prevent the exposure of any individual to radiation or airborne radioactive materials in excess of the limits established in this chapter.

(C) Caution signs are not required to be posted at areas or rooms containing radioactive material for periods of less than twenty-four hours provided that such materials are constantly attended by an individual during such periods, or that there is no chance that any individual would come into the area or room not knowing a hazard exists.

(D) Radiation areas and high radiation areas which result from the operation of therapeutic X-ray machines operated at potentials of 60 kvp and below or from the operation of diagnostic X-ray machines shall be exempt from the posting requirements of this rule provided that the operator of the equipment has taken precautions to insure that no individual other than the patient shall be in the radiation area.

Auth: section 192.420 RSMo (1969). Original rule filed Nov. 9, 1964, effective Dec. 9, 1964.

13 CSR 50-90.110 Relative Biological Effectiveness Values

PURPOSE: The purpose of this rule is to list relative biological effectiveness (RBE) values which are referred to in other rules of this chapter.

(1) The RBE values in Table I are convenient approximations to relate dose in rads to dose in rems. The value will vary greatly with the biological effect being considered, the acuteness of the exposure and many other factors. The qualified expert should evaluate these factors for each situation, and should adjust the values accordingly.

Table I - RBE Values

Radiation	RBE
X-rays and gamma rays, of all energies and electrons and beta rays above 0.03 MEV	1.0
Fast neutrons and protons up to 10 MEV	10
Alpha particles	10
Heavy recoil nuclei	20

Auth: section 192.420 RSMo (1969). Original rule filed Nov. 9, 1964, effective Dec. 9, 1964.

13 CSR 50-90.120 General Requirements for Diagnostic X-ray Equipment

PURPOSE: The purpose of this rule is to establish general requirements for diagnostic x-ray equipment.

(1) The X-ray tube housing shall be of the protective diagnostic type.

(2) Total filtration shall be as follows:

(A) For fluoroscopic and radiographic equipment operating at 70 kvp and below, the total filtration permanently in the useful beam, for routine use, shall be equivalent to at least 1.5 mm of aluminum. This condition shall be considered fulfilled if the half value layer (HVL) of the useful beam is 1.5 mm of aluminum or greater.

(B) For fluoroscopic and radiographic equipment capable of operating above 70 kvp, the total filtration permanently in the useful beam shall be equivalent to at least 2.5 mm of aluminum. This condition shall be considered fulfilled if the HVL of the useful beam is 2.5 mm of aluminum or greater.

(3) The exposure switch for routine diagnostic X-rays or routine diagnostic fluoroscopy shall be of the "dead-man" type or time limiting switch acceptable to the division.

(4) Diaphragms or cones shall be used for collimating the useful beam and shall provide the same degree of protection as the tube housing.

Auth: section 192.420 RSMo (1969). Original rule filed Nov. 9, 1964, effective Dec. 9, 1964.

13 CSR 50-90.130 Special Requirements for Medical Fluoroscopic Installations

PURPOSE: The purpose of this rule is to establish special requirements for medical fluoroscopic installations.

(1) All fluoroscopes shall be so constructed that the entire cross section of the useful beam is attenuated by a primary barrier. Collimators and adjustable diaphragms or shutters shall be provided to restrict the size of the useful beam to less than the area of the barrier. For conventional fluoroscopes, this requirement is met if, when the adjustable diaphragm is open to its fullest extent, an unilluminated two centimeters margin is left on the fluorescent screen with the screen centered in the beam at a distance of 35 cm. (14 inches) from the panel or table top. The margin requirement does not apply to installations where image amplifiers are used, but a protective shield shall be provided in these installations so that the useful beam does not produce a radiation hazard.

(2) Accessory shielding devices (such as cones, curtains, bucky slot covers, shielding between patient and fluoroscopist) shall be used as required to reduce the exposure dose rate to not more than 50 milliroentgens per hour in the area adjacent to the machine normally occupied by the fluoroscopist and his assistants during fluoroscopy.

(3) The target to panel distance shall not be less than

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18 inches.

(4) A manually reset cumulative timing device shall be used which will either indicate elapsed time by an audible signal or turn off the apparatus when the total exposure exceeds a predetermined limit given in one or a series of exposures. The device shall have a maximum range of 5 minutes.

(5) The primary beam barrier should have a lead equivalent of at least 2.0 millimeters and shall not be less than 1.5 millimeters for 100 kvp, should be at least 2.4 millimeters and shall be not less than 1.8 millimeters for 125 kvp, and should be at least 2.7 millimeters and shall be not less than 2.0 millimeters for 150 kvp. For conventional fluoroscopes, this requirement may be assumed to have been met if the exposure dose rate measured at the viewing surface of the fluorescent screen does not exceed 50 milliroentgens per hour with the screen in the primary beam of the fluoroscope without a patient, under normal operating conditions.

(6) Collimators and adjustable diaphragms or shutters to restrict the size of the useful beam shall provide a minimum of 2.0 millimeters lead equivalent protection for 100 kvp, 2.4 millimeters for 125 kvp, and 2.7 millimeters for 150 kvp.

(7) For routine fluoroscopy the dose rate measured at the panel or table top shall not exceed 6 roentgens per minute.

(8) Mobile fluoroscopic equipment shall meet the requirements of sections (1) through (7) of this rule except that:

(A) In the absence of panel or table top, a cone or spacer frame shall limit the target-to-skin distance to not less than 12 inches.

(B) It shall be impossible to operate the machine when the collimating cone or diaphragm is not in place.

(C) The maximum permissible exposure dose rate of 6 roentgens per minute shall be measured at the minimum target-to-skin distance.

Auth: section 192.420 RSMo (1969). Original rule filed Nov. 9, 1964, effective Dec. 9, 1964.

13 CSR 50-90.140 Special Requirements For Medical Radiographic Installations

PURPOSE: The purpose of this rule is to establish special requirements for medical radiographic x-ray installations.

(1) A device shall be provided to terminate the exposure after a preset time or exposure.

(2) The exposure switch shall be so arranged that it cannot be conveniently operated outside a shielded area. Exposure switches for spot film devices used in conjunction with fluoroscopic tables are excepted from this requirement.

Auth: section 192.420 RSMo (1969). Original rule filed Nov. 9, 1964, effective Dec. 9, 1964.

13 CSR 50-90.150 Special Requirements For Dental Radiographic Installations

PURPOSE: The purpose of this rule is to establish special requirements for dental radiographic installations.

(1) The diameter of the useful beam at the cone tip should be not more than 2.75 inches and shall be not more than three inches for routine intraoral radiography.

(2) A device shall be provided to terminate the exposure after a preset time or exposure.

(3) The exposure control switch shall be provided with a cord sufficiently long so that the operator can stand at least 6 feet from the tube housing for all exposures and well away from the useful beam.

Auth: section 192.420 RSMo (1969). Original rule filed Nov. 9, 1964, effective Dec. 9, 1964.

13 CSR 50-90.160 Special Requirements for Mobile Medical Radiographic Installations

PURPOSE: The purpose of this rule is to establish special requirements for mobile medical radiographic installations.

(1) All mobile equipment shall be provided with cones or frames so that the minimum target-to-skin distance is at least 18 inches.

(2) The exposure control switch shall be so arranged that the operator can stand at least 6 feet from the patient and outside the primary beam for all exposures.

(3) A device shall be provided to terminate the exposure after a preset time.

Auth: section 192.420 RSMo (1969). Original rule filed Nov. 9, 1964, effective Dec. 9, 1964.

13 CSR 50-90.170 Special Requirements for Photofluorographic Installations

PURPOSE: The purpose of this rule is to establish special requirements for photofluorographic installations.

(1) A collimator shall restrict the useful beam to the area of the fluorographic screen.

(2) The exposure switch shall be so arranged that it cannot be conveniently operated outside a shielded area. Exposure switches for spot film devices used in conjunction with fluoroscopic tables are exempted from this requirement.

(3) A device shall be provided to terminate the exposure after a preset time or exposure.

(4) Output of the photofluorographic installation shall not exceed one roentgen per exposure at the panel.

Auth: section 192.420 RSMo (1969). Original rule filed Nov. 9, 1964, effective Dec. 9, 1964.

13 CSR 50-90.180 Requirements For Radiation Therapy Installations

PURPOSE: The purpose of this rule is to establish requirements for radiation therapy installations.

(1) The radiation source housing shall be a protective therapeutic type.

(2) Permanent diaphragms or cones shall be used for collimating the useful beam and shall afford the same degree of protection as the radiation source housing. Adjustable or removable beam-defining devices shall not transmit more than 5 per cent of the useful beam obtained at the maximum kilovoltage and with the maximum treatment filter.

(3) The filter system shall be so arranged as to permit proper filter selection and alignment. Filters shall be secured in place to prevent them from dropping out during treatment. The filter slot shall be so constructed that the radiation escaping through it does not exceed one roentgen per hour at one meter.

(4) The radiation source shall be centered and mounted so that it cannot turn or slide with respect to the aperture when the source is in the "on" position.

(5) Means shall be provided to immobilize the radiation source during stationary radiation treatment.

(6) A timer shall be provided to terminate the exposure after a preset time.

(7) With equipment operating above 60 kvp, interlocks shall be provided so that when any door to the treatment room is opened either the machine will be shut off automatically or the radiation level within the room will be reduced to an average of not more than two milliroentgens per hour and a maximum of 10 milliroentgens per hour at a distance of one meter in any direction from the target. After such a shutoff, or reduction in output, it shall be possible to restore the machine to full operation only from the control panel.

(8) The control shall be located outside of the treatment room or within a protective booth.

(9) Equipment utilizing shutters to control the useful beam shall have a shutter position indicator on the control panel.

(10) There shall be on the control panel some easily discernible device which will give positive information as to whether or not the source of the ionizing radiation is in the "on" position.

Auth: section 192.420 RSMo (1969). Original rule filed Nov. 9, 1964, effective Dec. 9, 1964.

13 CSR 50-90.190 Requirements for Room Shielding

PURPOSE: The purpose of this rule is to provide necessary information regarding requirements for room shielding for diagnostic and therapeutic installations.

(1) The requirements for room shielding shall conform to the requirements defined in the various handbooks published by the U. S. Department of Commerce, National Bureau of Standards, and any revisions to

said handbooks.

Auth: section 192.420 RSMo (1969). Original rule filed Nov. 9, 1964, effective Dec. 9, 1964.

13 CSR 50-90.200 Shoe-Fitting Devices

PURPOSE: This rule prohibits the use of radiation for the purpose of selling footwear.

(1) It shall be unlawful for any person, partnership, association, or corporation to operate or maintain within this state, any fitting devices or machines which use fluoroscopic, x-ray, or radiation principles for the purpose of selling footwear through commercial outlets.

Auth: section 192.420 RSMo (1969). Original rule filed Nov. 9, 1964, effective Dec. 9, 1964.

APPENDIX I

TABLE 1 - EXEMPT QUANTITIES OF RADIOISOTOPES

	Column 1 Unsealed Sources (Microcuries)	Column 2 Sealed Sources (Microcuries)
Actinium 227	0.1	1
Americium 241	0.1	1
Antimony 124	1	10
Arsenic 73	10	100
74	10	100
76	10	100
77	10	100
Astatine 211	0.1	10
Barium-Lanthanum 140	1	10
Beryllium 7	100	1000
Bromine 82	10	100
Cadmium-Silver 109	10	100
Calcium 45	1	10
Carbon 14	1000	10000
Cerium-Praseodymium 144	1	10
Cesium-Barium 137	10	100
Chlorine 36	10	100
Chromium 51	100	1000

	Column 1 Unsealed Sources (Microcuries) Continued	Column 2 Sealed Sources (Microcuries) Continued
Cobalt 58	10	100
60	10	100
Copper 64	10	100
Curium 242	0.1	1
Europium 154	1	10
Fluorine 18	100	1000
Gallium 72	10	100
Germanium 71	100	1000
Gold 196	10	100
198	10	100
199	10	100
Holmium 166	10	100
Hydrogen (Tritium)3	1000	10000
Indium 114	1	10
Iodine 131	1	10
132	10	100
Iridium 190	10	100
192	10	100
Iron 55	10	100
59	1	10
Krypton 85	1000	10000
Lanthanum 140	10	100
Lead 203	10	100
210 + dtrs	0.1	1
Lutecium 177	10	100
Manganese 52	10	100
54	10	100
56	10	100
Molybdenum 99	10	100
Nickel 59	10	100
63	10	100
Niobium 95	10	100
Palladium-Silver 109	10	100
Palladium-Rhodium 103	10	100
Phosphorus 32	10	100
Platinum 191	10	100
193	10	100
Plutonium 239	0.1	1

	Column 1 Unsealed Sources (Microcuries) Continued	Column 2 Sealed Sources (Microcuries) Continued
Polonium 210	0.1	1
Potassium 42	10	100
Praseodymium 143	10	100
Promethium 147	10	100
Radium 226	0.1	1
Rhenium 183	10	100
186	10	100
Rhodium 105	10	100
Rubidium 86	10	100
Ruthenium 103	10	100
Ruthenium-Rhodium 106	1	10
Samarium 151	1	10
153	10	100
Scandium 46	10	100
47	10	100
48	10	100
Silver 105	10	100
110	10	100
111	10	100
Sodium 22	10	100
24	10	100
Strontium 89	1	10
Strontium-Yttrium 90	0.1	1.0
Sulfur 35	10	100
Tantalum 182	10	100
Technetium 96	1	10
99	1	10
Tellurium 127	10	100
129	10	100
Thallium 200	10	100
201	100	1000
202	10	100
204	10	100
Thorium nat.	100	1000
Thorium-Protoactinium 234	1	10
Thulium-Ytterbium 170	1	10
Tin 113	10	100
Tungsten 181	10	100
185	10	100
Uranium 233	0.1	1
natural	1000	10000
Vanadium 48	10	100
Yttrium 91	1	10
Zinc 65	10	100
Zirconium Niobium 95	10	100

TABLE 2

CONCENTRATIONS IN WATER AND AIR ABOVE NATURAL BACKGROUND

ELEMENT (atomic number)	ISOTOPE[1]		Column 1 AIR (uc/ml)	Column 2 WATER (uc/ml)	Column 3 AIR (uc/ml)
Actinium (89)	Ac 227	S	2×10^{-12}	2×10^{-6}	8×10^{-14}
		I	3×10^{-11}	3×10^{-4}	9×10^{-13}
	Ac 228	S	8×10^{-8}	9×10^{-5}	3×10^{-9}
		I	2×10^{-8}	9×10^{-5}	6×10^{-10}
Americium (95)	Am 241	S	6×10^{-12}	4×10^{-6}	2×10^{-13}
		I	1×10^{-10}	2×10^{-4}	4×10^{-12}
	Am 243	S	6×10^{-12}	4×10^{-6}	2×10^{-13}
		I	1×10^{-10}	3×10^{-5}	4×10^{-12}
Antimony (51)	Sb 122	S	2×10^{-7}	3×10^{-5}	6×10^{-9}
		I	1×10^{-7}	3×10^{-5}	5×10^{-9}
	Sb 124	S	2×10^{-7}	2×10^{-5}	5×10^{-9}
		I	2×10^{-8}	2×10^{-5}	7×10^{-10}
	Sb 125	S	5×10^{-7}	1×10^{-4}	2×10^{-8}
		I	3×10^{-8}	1×10^{-4}	9×10^{-10}
Argon[2] (18)	A 37	Sub	6×10^{-3}	—	1×10^{-4}
	A 41	Sub	2×10^{-6}	—	4×10^{-8}
Arsenic (33)	As 73	S	2×10^{-6}	5×10^{-4}	7×10^{-8}
		I	4×10^{-7}	5×10^{-4}	1×10^{-8}
	As 74	S	3×10^{-7}	5×10^{-5}	1×10^{-8}
		I	1×10^{-7}	5×10^{-5}	4×10^{-9}
	As 76	S	1×10^{-7}	2×10^{-5}	4×10^{-9}
		I	1×10^{-7}	2×10^{-5}	3×10^{-9}
	As 77	S	5×10^{-7}	8×10^{-5}	2×10^{-8}
		I	4×10^{-7}	8×10^{-5}	1×10^{-8}
Astatine (85)	At 211	S	7×10^{-9}	2×10^{-6}	2×10^{-10}
		I	3×10^{-8}	7×10^{-5}	1×10^{-9}
Barium (56)	Ba 131	S	1×10^{-6}	2×10^{-4}	4×10^{-8}
		I	4×10^{-7}	2×10^{-4}	1×10^{-8}
	Ba 140	S	1×10^{-7}	3×10^{-5}	4×10^{-9}
		I	4×10^{-8}	2×10^{-5}	1×10^{-9}
Berkelium (97)	Bk 249	S	9×10^{-10}	6×10^{-4}	3×10^{-11}
		I	1×10^{-7}	6×10^{-4}	4×10^{-9}
Beryllium (4)	Be 7	S	6×10^{-6}	2×10^{-3}	2×10^{-7}
		I	1×10^{-6}	2×10^{-3}	4×10^{-8}
Bismuth (83)	Bi 206	S	2×10^{-7}	4×10^{-5}	6×10^{-9}
		I	1×10^{-7}	4×10^{-5}	5×10^{-9}
	Bi 207	S	2×10^{-7}	6×10^{-5}	6×10^{-9}
		I	1×10^{-8}	6×10^{-5}	5×10^{-10}
	Bi 210	S	6×10^{-9}	4×10^{-5}	2×10^{-10}
		I	6×10^{-9}	4×10^{-5}	2×10^{-10}
	Bi 212	S	1×10^{-7}	4×10^{-4}	3×10^{-9}
		I	2×10^{-7}	4×10^{-4}	7×10^{-9}
Bromine (35)	Br 82	S	1×10^{-6}	3×10^{-4}	4×10^{-8}
		I	2×10^{-7}	4×10^{-5}	6×10^{-9}
Cadmium (48)	Cd 109	S	5×10^{-8}	2×10^{-4}	2×10^{-9}
		I	7×10^{-8}	2×10^{-4}	3×10^{-9}
	Cd 115m	S	4×10^{-8}	3×10^{-5}	1×10^{-9}
		I	4×10^{-8}	3×10^{-5}	1×10^{-9}
	Cd 115	S	2×10^{-7}	3×10^{-5}	8×10^{-9}
		I	2×10^{-7}	4×10^{-5}	6×10^{-9}
Calcium (20)	Ca 45	S	3×10^{-8}	9×10^{-6}	1×10^{-9}
		I	1×10^{-7}	2×10^{-4}	4×10^{-9}
	Ca 47	S	2×10^{-7}	5×10^{-5}	6×10^{-9}
		I	2×10^{-7}	3×10^{-5}	6×10^{-9}
Californium (98)	Cf 249	S	2×10^{-12}	4×10^{-6}	5×10^{-14}
		I	1×10^{-10}	2×10^{-5}	3×10^{-12}
	Cf 250	S	5×10^{-12}	1×10^{-5}	2×10^{-13}
		I	1×10^{-10}	3×10^{-5}	3×10^{-12}
	Cf 252	S	6×10^{-12}	7×10^{-8}	2×10^{-13}
		I	1×10^{-10}	2×10^{-5}	4×10^{-12}
Carbon (6)	C 14 (CO_2)	S	4×10^{-6}	8×10^{-4}	1×10^{-7}
		Sub	5×10^{-5}	—	1×10^{-6}
Cerium (58)	Ce 141	S	4×10^{-7}	9×10^{-5}	2×10^{-8}
		I	2×10^{-7}	9×10^{-5}	5×10^{-9}
	Ce 143	S	3×10^{-7}	4×10^{-5}	9×10^{-9}
		I	2×10^{-7}	4×10^{-5}	7×10^{-9}
	Ce 144	S	1×10^{-8}	1×10^{-5}	3×10^{-10}
		I	6×10^{-9}	1×10^{-5}	2×10^{-10}
Cesium (55)	Cs 131	S	1×10^{-5}	2×10^{-3}	4×10^{-7}
		I	3×10^{-6}	9×10^{-4}	1×10^{-7}
	Cs 134m	S	4×10^{-5}	6×10^{-3}	1×10^{-6}
		I	6×10^{-6}	1×10^{-3}	2×10^{-7}
	Cs 134	S	4×10^{-8}	9×10^{-6}	1×10^{-9}
		I	1×10^{-8}	4×10^{-5}	4×10^{-10}
	Cs 135	S	5×10^{-7}	1×10^{-4}	2×10^{-8}
		I	9×10^{-8}	2×10^{-4}	3×10^{-9}
	Cs 136	S	4×10^{-7}	9×10^{-5}	1×10^{-8}
		I	2×10^{-7}	6×10^{-5}	6×10^{-9}
	Cs 137	S	6×10^{-8}	2×10^{-5}	2×10^{-9}
		I	1×10^{-8}	4×10^{-5}	5×10^{-10}
Chlorine (17)	Cl 36	S	4×10^{-7}	8×10^{-5}	1×10^{-8}
		I	2×10^{-8}	6×10^{-5}	8×10^{-10}
	Cl 38	S	3×10^{-6}	4×10^{-4}	9×10^{-8}
		I	2×10^{-6}	4×10^{-4}	7×10^{-8}
Chromium (24)	Cr 51	S	1×10^{-5}	2×10^{-3}	4×10^{-7}
		I	2×10^{-6}	2×10^{-3}	8×10^{-8}
Cobalt (27)	Co 57	S	3×10^{-6}	5×10^{-4}	1×10^{-7}
		I	2×10^{-7}	4×10^{-4}	6×10^{-9}
	Co 58m	S	2×10^{-5}	3×10^{-3}	6×10^{-7}
		I	9×10^{-6}	2×10^{-3}	3×10^{-7}
	Co 58	S	8×10^{-7}	1×10^{-4}	3×10^{-8}
		I	5×10^{-8}	9×10^{-5}	2×10^{-9}
	Co 60	S	3×10^{-7}	5×10^{-5}	1×10^{-8}
		I	9×10^{-9}	3×10^{-5}	3×10^{-10}
Copper (29)	Cu 64	S	2×10^{-6}	3×10^{-4}	7×10^{-8}
		I	1×10^{-6}	2×10^{-4}	4×10^{-8}
Curium (96)	Cm 242	S	1×10^{-10}	2×10^{-5}	4×10^{-12}
		I	2×10^{-10}	3×10^{-5}	6×10^{-12}
	Cm 243	S	6×10^{-12}	5×10^{-6}	2×10^{-13}
		I	1×10^{-10}	2×10^{-5}	3×10^{-12}
	Cm 244	S	9×10^{-12}	7×10^{-6}	3×10^{-13}
		I	1×10^{-10}	3×10^{-5}	3×10^{-12}
	Cm 245	S	5×10^{-12}	4×10^{-6}	2×10^{-13}
		I	1×10^{-10}	3×10^{-5}	4×10^{-12}
	Cm 246	S	5×10^{-12}	4×10^{-6}	2×10^{-13}
		I	1×10^{-10}	3×10^{-5}	4×10^{-12}
Dysprosium (66)	Dy 165	S	3×10^{-6}	4×10^{-4}	9×10^{-8}
		I	2×10^{-6}	4×10^{-4}	7×10^{-8}
	Dy 166	S	2×10^{-7}	4×10^{-5}	8×10^{-9}
		I	2×10^{-7}	4×10^{-5}	7×10^{-9}
Erbium (68)	Er 169	S	6×10^{-7}	9×10^{-5}	2×10^{-8}
		I	4×10^{-7}	9×10^{-5}	1×10^{-8}
	Er 171	S	7×10^{-7}	1×10^{-4}	2×10^{-8}
		I	6×10^{-7}	1×10^{-4}	2×10^{-8}
Europium (63)	Eu 152 (TV/2=9.2 hrs)	S	4×10^{-7}	6×10^{-5}	1×10^{-8}
		I	3×10^{-7}	6×10^{-5}	1×10^{-8}
	Eu 152 (TV/2=13 yrs)	S	1×10^{-8}	8×10^{-5}	4×10^{-10}
		I	2×10^{-8}	8×10^{-5}	6×10^{-10}
	Eu 154	S	4×10^{-9}	2×10^{-5}	1×10^{-10}
		I	7×10^{-9}	2×10^{-5}	2×10^{-10}
	Eu 155	S	9×10^{-8}	2×10^{-4}	3×10^{-9}
		I	7×10^{-8}	2×10^{-4}	3×10^{-9}
Fluorine (9)	F 18	S	5×10^{-6}	8×10^{-4}	2×10^{-7}
		I	3×10^{-6}	5×10^{-4}	9×10^{-8}
Gadolinium (64)	Gd 153	S	2×10^{-7}	2×10^{-4}	8×10^{-9}
		I	9×10^{-8}	2×10^{-4}	3×10^{-9}

[1]Soluble (S); Insoluble (I); Submersion in a cloud of gaseous material (Sub).

[2]Noble gas — Values given for submersion in an infinite cloud.

ELEMENT (atomic number)	ISOTOPE[1]		Column 1 AIR (uc/ml)	Column 2 WATER (uc/ml)	Column 3 AIR (uc/ml)
	Gd 159	S	5×10^{-7}	8×10^{-5}	2×10^{-8}
		I	4×10^{-7}	8×10^{-5}	1×10^{-8}
Gallium (31)	Ga 72	S	2×10^{-7}	4×10^{-5}	8×10^{-9}
		I	2×10^{-7}	4×10^{-5}	6×10^{-9}
Germanium (32)	Ge 71	S	1×10^{-5}	2×10^{-3}	4×10^{-7}
		I	6×10^{-6}	2×10^{-3}	2×10^{-7}
Gold (79)	Au 196	S	1×10^{-6}	2×10^{-4}	4×10^{-8}
		I	6×10^{-7}	1×10^{-4}	2×10^{-8}
	Au 198	S	3×10^{-7}	5×10^{-5}	1×10^{-8}
		I	2×10^{-7}	5×10^{-5}	8×10^{-9}
	Au 199	S	1×10^{-6}	2×10^{-4}	4×10^{-8}
		I	8×10^{-7}	2×10^{-4}	3×10^{-8}
Hafnium (72)	Hf 181	S	4×10^{-8}	7×10^{-5}	1×10^{-9}
		I	7×10^{-8}	7×10^{-5}	3×10^{-9}
Holmium (67)	HO 166	S	2×10^{-7}	3×10^{-5}	7×10^{-9}
		I	2×10^{-7}	3×10^{-5}	6×10^{-9}
Hydrogen (1)	H3	S	5×10^{-6}	3×10^{-3}	2×10^{-7}
		Sub	2×10^{-3}	—	4×10^{-5}
Indium (49)	In 113m	S	8×10^{-6}	1×10^{-3}	3×10^{-7}
		I	7×10^{-6}	1×10^{-3}	2×10^{-7}
	In 114m	S	1×10^{-7}	2×10^{-5}	4×10^{-9}
		I	2×10^{-8}	2×10^{-5}	7×10^{-10}
	In 115m	S	2×10^{-6}	4×10^{-4}	8×10^{-8}
		I	2×10^{-6}	4×10^{-4}	6×10^{-8}
	In 115	S	2×10^{-7}	9×10^{-5}	9×10^{-9}
		I	3×10^{-8}	9×10^{-5}	1×10^{-9}
Iodine (53)	I 126	S	8×10^{-9}	2×10^{-6}	3×10^{-10}
		I	3×10^{-7}	9×10^{-5}	1×10^{-8}
	I 129	S	2×10^{-9}	4×10^{-7}	6×10^{-11}
		I	7×10^{-8}	2×10^{-4}	2×10^{-9}
	I 131	S	9×10^{-9}	2×10^{-6}	3×10^{-10}
		I	3×10^{-7}	6×10^{-5}	1×10^{-8}
	I 132	S	2×10^{-7}	6×10^{-5}	8×10^{-9}
		I	9×10^{-7}	2×10^{-4}	3×10^{-8}
	I 133	S	3×10^{-8}	7×10^{-6}	1×10^{-9}
		I	2×10^{-7}	4×10^{-5}	7×10^{-9}
	I 134	S	5×10^{-7}	1×10^{-4}	2×10^{-8}
		I	3×10^{-6}	6×10^{-4}	1×10^{-7}
	I 135	S	1×10^{-7}	2×10^{-5}	4×10^{-9}
		I	4×10^{-7}	7×10^{-5}	1×10^{-8}
Iridium (77)	Ir 190	S	1×10^{-6}	2×10^{-4}	4×10^{-8}
		I	4×10^{-7}	2×10^{-4}	1×10^{-8}
	Ir 192	S	1×10^{-7}	1×10^{-5}	4×10^{-9}
		I	3×10^{-8}	1×10^{-5}	9×10^{-10}
	Ir 194	S	2×10^{-7}	3×10^{-5}	8×10^{-9}
		I	2×10^{-7}	3×10^{-5}	5×10^{-9}
Iron (26)	Fe 55	S	9×10^{-7}	8×10^{-4}	3×10^{-8}
		I	1×10^{-6}	2×10^{-3}	3×10^{-8}
	Fe 59	S	1×10^{-7}	6×10^{-5}	5×10^{-9}
		I	5×10^{-8}	5×10^{-5}	2×10^{-9}
Krypton[2] (36)	Kr 85m	Sub	6×10^{-6}	—	1×10^{-7}
	Kr 85	Sub	1×10^{-5}	—	3×10^{-7}
	Kr 87	Sub	1×10^{-6}	—	2×10^{-8}
Lanthanum (57)	La 140	S	2×10^{-7}	2×10^{-5}	5×10^{-9}
		I	1×10^{-7}	2×10^{-5}	4×10^{-9}
Lead (82)	Pb 203	S	3×10^{-6}	4×10^{-4}	9×10^{-8}
		I	2×10^{-6}	4×10^{-4}	6×10^{-8}
	Pb 210	S	1×10^{-10}	1×10^{-7}	4×10^{-12}
		I	2×10^{-10}	2×10^{-4}	8×10^{-12}
	Pb 212	S	2×10^{-8}	2×10^{-5}	6×10^{-10}
		I	2×10^{-8}	2×10^{-5}	7×10^{-10}
Lutecium (71)	Lu 177	S	6×10^{-7}	1×10^{-4}	2×10^{-8}
		I	5×10^{-7}	1×10^{-4}	2×10^{-8}
Manganese (25)	Mn 52	S	2×10^{-7}	3×10^{-5}	7×10^{-9}
		I	1×10^{-7}	3×10^{-5}	5×10^{-9}
	Mn 54	S	4×10^{-7}	1×10^{-4}	1×10^{-8}
		I	4×10^{-8}	1×10^{-4}	1×10^{-9}
	Mn 56	S	8×10^{-7}	1×10^{-4}	3×10^{-8}
		I	5×10^{-7}	1×10^{-4}	2×10^{-8}
Mercury (80)	Hg 197m	S	7×10^{-7}	2×10^{-4}	3×10^{-8}
		I	8×10^{-7}	2×10^{-4}	3×10^{-8}
	Hg 197	S	1×10^{-6}	3×10^{-4}	4×10^{-8}
		I	3×10^{-6}	5×10^{-4}	9×10^{-8}
	Hg 203	S	7×10^{-8}	2×10^{-5}	2×10^{-9}
		I	1×10^{-7}	1×10^{-4}	4×10^{-9}
Molybdenum (42)	Mo 99	S	7×10^{-7}	2×10^{-4}	3×10^{-8}
		I	2×10^{-7}	4×10^{-5}	7×10^{-9}
Neodymium (60)	Nd 144	S	8×10^{-11}	7×10^{-5}	3×10^{-12}
		I	3×10^{-10}	8×10^{-5}	1×10^{-11}
	Nd 147	S	4×10^{-7}	6×10^{-5}	1×10^{-8}
		I	2×10^{-7}	6×10^{-5}	8×10^{-9}
	Nd 149	S	2×10^{-6}	3×10^{-4}	6×10^{-8}
		I	1×10^{-6}	3×10^{-4}	5×10^{-8}
Neptunium (93)	Np 237	S	4×10^{-12}	3×10^{-6}	1×10^{-13}
		I	1×10^{-10}	3×10^{-5}	4×10^{-12}
	Np 239	S	8×10^{-7}	1×10^{-4}	3×10^{-8}
		I	7×10^{-7}	1×10^{-4}	2×10^{-8}
Nickel (28)	Ni 59	S	5×10^{-7}	2×10^{-4}	2×10^{-8}
		I	8×10^{-7}	2×10^{-3}	3×10^{-8}
	Ni 63	S	6×10^{-8}	3×10^{-5}	2×10^{-9}
		I	3×10^{-7}	7×10^{-4}	1×10^{-8}
	Ni 65	S	9×10^{-7}	1×10^{-4}	3×10^{-8}
		I	5×10^{-7}	1×10^{-4}	2×10^{-8}
Niobium (Columbium) (41)	Nb 93m	S	1×10^{-7}	4×10^{-4}	4×10^{-9}
		I	2×10^{-7}	4×10^{-4}	5×10^{-9}
	Nb 95	S	5×10^{-7}	1×10^{-4}	2×10^{-8}
		I	1×10^{-7}	1×10^{-4}	3×10^{-9}
	Nb 97	S	6×10^{-6}	9×10^{-4}	2×10^{-7}
		I	5×10^{-6}	9×10^{-4}	2×10^{-7}
Osmium (76)	Os 185	S	5×10^{-7}	7×10^{-5}	2×10^{-8}
		I	5×10^{-8}	7×10^{-5}	2×10^{-9}
	Os 191m	S	2×10^{-5}	3×10^{-3}	6×10^{-7}
		I	9×10^{-6}	2×10^{-3}	3×10^{-7}
	Os 191	S	1×10^{-6}	2×10^{-4}	4×10^{-8}
		I	4×10^{-7}	2×10^{-4}	1×10^{-8}
	Os 193	S	4×10^{-7}	6×10^{-5}	1×10^{-8}
		I	3×10^{-7}	5×10^{-5}	9×10^{-9}
Palladium (46)	Pd 103	S	1×10^{-6}	3×10^{-4}	5×10^{-8}
		I	7×10^{-7}	3×10^{-4}	3×10^{-8}
	Pd 109	S	6×10^{-7}	9×10^{-5}	2×10^{-8}
		I	4×10^{-7}	7×10^{-5}	1×10^{-8}
Phosphorus (15)	P 32	S	7×10^{-8}	2×10^{-5}	2×10^{-9}
		I	8×10^{-8}	2×10^{-5}	3×10^{-9}
Platinum (78)	Pt 191	S	8×10^{-7}	1×10^{-4}	3×10^{-8}
		I	6×10^{-7}	1×10^{-4}	2×10^{-8}
	Pt 193m	S	7×10^{-6}	1×10^{-3}	2×10^{-7}
		I	5×10^{-6}	1×10^{-3}	2×10^{-7}
	Pt 193	S	1×10^{-6}	9×10^{-4}	4×10^{-8}
		I	3×10^{-7}	2×10^{-3}	1×10^{-8}
	Pt 197m	S	6×10^{-6}	1×10^{-3}	2×10^{-7}
		I	5×10^{-6}	9×10^{-4}	2×10^{-7}
	Pt 197	S	8×10^{-7}	1×10^{-4}	3×10^{-8}
		I	6×10^{-7}	1×10^{-4}	2×10^{-8}
Plutonium (94)	Pu 238	S	2×10^{-12}	5×10^{-6}	7×10^{-14}
		I	3×10^{-11}	3×10^{-5}	1×10^{-12}
	Pu 239	S	2×10^{-12}	5×10^{-6}	6×10^{-14}
		I	4×10^{-11}	3×10^{-5}	1×10^{-12}
	Pu 240	S	2×10^{-12}	5×10^{-6}	6×10^{-14}
		I	4×10^{-11}	3×10^{-5}	1×10^{-12}
	Pu 241	S	9×10^{-11}	2×10^{-4}	3×10^{-12}
		I	4×10^{-8}	1×10^{-3}	1×10^{-9}
	Pu 242	S	2×10^{-12}	5×10^{-6}	6×10^{-14}
		I	4×10^{-11}	3×10^{-5}	1×10^{-12}
Polonium (84)	Po 210	S	5×10^{-10}	7×10^{-7}	2×10^{-11}
		I	2×10^{-10}	3×10^{-5}	7×10^{-12}

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ELEMENT (atomic number)	ISOTOPE[1]		Column 1 AIR (uc/ml)	Column 2 WATER (uc/ml)	Column 3 AIR (uc/ml)
Potassium (19)	K 42	S	2×10^{-6}	3×10^{-4}	7×10^{-8}
		I	1×10^{-7}	2×10^{-5}	4×10^{-9}
Praseodymium (59)	Pr 142	S	2×10^{-7}	3×10^{-5}	7×10^{-9}
		I	2×10^{-7}	3×10^{-5}	5×10^{-9}
	Pr 143	S	3×10^{-7}	5×10^{-5}	1×10^{-8}
		I	2×10^{-7}	[illegible]	[illegible]
Promethium (61)	Pm 147	S	6×10^{-8}	2×10^{-4}	[illegible]
		I	1×10^{-7}	2×10^{-4}	3×10^{-9}
	Pm 149	S	3×10^{-7}	4×10^{-5}	1×10^{-8}
		I	2×10^{-7}	4×10^{-5}	8×10^{-9}
Protoactinium (91)	Pa 230	S	2×10^{-9}	2×10^{-4}	6×10^{-11}
		I	8×10^{-10}	3×10^{-4}	3×10^{-11}
	Pa 231	S	1×10^{-12}	9×10^{-7}	4×10^{-14}
		I	1×10^{-10}	2×10^{-5}	4×10^{-12}
	Pa 233	S	6×10^{-7}	1×10^{-4}	2×10^{-8}
		I	2×10^{-7}	1×10^{-4}	6×10^{-9}
Radium (88)	Ra 223	S	2×10^{-9}	7×10^{-7}	6×10^{-11}
		I	[illegible]	4×10^{-6}	8×10^{-12}
	Ra 224	S	5×10^{-9}	2×10^{-6}	2×10^{-10}
		I	7×10^{-10}	5×10^{-6}	2×10^{-11}
	Ra 226	S	3×10^{-11}	1×10^{-8}	1×10^{-12}
		I	2×10^{-7}	3×10^{-5}	6×10^{-9}
	Ra 228	S	7×10^{-11}	3×10^{-8}	2×10^{-12}
		I	4×10^{-11}	3×10^{-5}	1×10^{-12}
Radon (86)	Rn 220	S	3×10^{-7}	—	1×10^{-8}
		I	—	—	—
	Rn 222	S	3×10^{-8}	—	1×10^{-9}
Rhenium (75)	Re 183	S	3×10^{-6}	6×10^{-4}	9×10^{-8}
		I	2×10^{-7}	3×10^{-4}	5×10^{-9}
	Re 186	S	6×10^{-7}	9×10^{-5}	2×10^{-8}
		I	2×10^{-7}	5×10^{-5}	8×10^{-9}
	Re 187	S	9×10^{-6}	3×10^{-3}	3×10^{-7}
		I	5×10^{-7}	2×10^{-3}	2×10^{-8}
	Re 188	S	4×10^{-7}	6×10^{-5}	1×10^{-8}
		I	2×10^{-7}	3×10^{-5}	6×10^{-9}
Rhodium (45)	Rh 103m	S	8×10^{-5}	1×10^{-2}	3×10^{-6}
		I	6×10^{-5}	1×10^{-2}	2×10^{-6}
	Rh 105	S	8×10^{-7}	1×10^{-4}	3×10^{-8}
		I	5×10^{-7}	1×10^{-4}	2×10^{-8}
Rubidium (37)	Rb 86	S	3×10^{-7}	7×10^{-5}	1×10^{-8}
		I	7×10^{-8}	2×10^{-5}	2×10^{-9}
	Rb 87	S	5×10^{-7}	1×10^{-4}	2×10^{-8}
		I	7×10^{-8}	2×10^{-4}	2×10^{-9}
Ruthenium (44)	Ru 97	S	2×10^{-6}	4×10^{-4}	8×10^{-8}
		I	2×10^{-6}	3×10^{-4}	6×10^{-8}
	Ru 103	S	5×10^{-7}	8×10^{-5}	2×10^{-8}
		I	8×10^{-8}	8×10^{-5}	3×10^{-9}
	Ru 105	S	7×10^{-7}	1×10^{-4}	2×10^{-8}
		I	5×10^{-7}	1×10^{-4}	2×10^{-8}
	Ru 106	S	8×10^{-8}	1×10^{-5}	3×10^{-9}
		I	6×10^{-9}	1×10^{-5}	2×10^{-10}
Samarium (62)	Sm 147	S	7×10^{-11}	6×10^{-5}	2×10^{-12}
		I	3×10^{-10}	7×10^{-5}	9×10^{-12}
	Sm 151	S	6×10^{-8}	4×10^{-4}	2×10^{-9}
		I	1×10^{-7}	4×10^{-4}	5×10^{-9}
	Sm 153	S	5×10^{-7}	8×10^{-5}	2×10^{-8}
		I	4×10^{-7}	8×10^{-5}	1×10^{-8}
Scandium (21)	Sc 46	S	2×10^{-7}	4×10^{-5}	8×10^{-9}
		I	2×10^{-8}	4×10^{-5}	8×10^{-10}
	Sc 47	S	6×10^{-7}	9×10^{-5}	2×10^{-8}
		I	5×10^{-7}	9×10^{-5}	2×10^{-8}
	Sc 48	S	2×10^{-7}	3×10^{-5}	6×10^{-9}
		I	1×10^{-7}	3×10^{-5}	5×10^{-9}
Selenium (34)	Se 75	S	1×10^{-6}	3×10^{-4}	4×10^{-8}
		I	1×10^{-7}	3×10^{-4}	4×10^{-9}
Silicon (14)	Si 31	S	6×10^{-6}	9×10^{-4}	2×10^{-7}
		I	1×10^{-6}	2×10^{-4}	3×10^{-8}

ELEMENT (atomic number)	ISOTOPE[1]		Column 1 AIR (uc/ml)	Column 2 WATER (uc/ml)	Column 3 AIR (uc/ml)
Silver (47)	Ag 105	S	6×10^{-7}	1×10^{-4}	2×10^{-8}
		I	8×10^{-8}	1×10^{-4}	3×10^{-9}
	Ag 110m	S	2×10^{-7}	3×10^{-5}	7×10^{-9}
		I	1×10^{-8}	3×10^{-5}	3×10^{-10}
	Ag 111	S	3×10^{-7}	4×10^{-5}	1×10^{-8}
		I	2×10^{-7}	4×10^{-5}	8×10^{-9}
Sodium (11)	Na 22	S	2×10^{-7}	4×10^{-5}	6×10^{-9}
		I	9×10^{-9}	3×10^{-5}	3×10^{-10}
	Na 24	S	1×10^{-6}	2×10^{-4}	4×10^{-8}
		I	1×10^{-7}	3×10^{-5}	5×10^{-9}
Strontium (38)	Sr 85m	S	4×10^{-5}	7×10^{-3}	1×10^{-6}
		I	3×10^{-5}	7×10^{-3}	1×10^{-6}
	Sr 85	S	2×10^{-7}	[illegible]	8×10^{-9}
		I	1×10^{-7}	[illegible]	4×10^{-9}
	Sr 89	S	3×10^{-8}	1×10^{-5}	1×10^{-9}
		I	4×10^{-8}	3×10^{-5}	1×10^{-9}
	Sr 90	S	3×10^{-10}	1×10^{-7}	1×10^{-11}
		I	5×10^{-9}	4×10^{-5}	2×10^{-10}
	Sr 91	S	4×10^{-7}	7×10^{-5}	2×10^{-8}
		I	3×10^{-7}	5×10^{-5}	9×10^{-9}
	Sr 92	S	4×10^{-7}	7×10^{-5}	2×10^{-8}
		I	3×10^{-7}	6×10^{-5}	1×10^{-8}
Sulfur (16)	S 35	S	3×10^{-7}	6×10^{-5}	9×10^{-9}
		I	3×10^{-7}	3×10^{-4}	9×10^{-9}
Tantalum (73)	Ta 182	S	4×10^{-8}	4×10^{-5}	1×10^{-9}
		I	2×10^{-8}	4×10^{-5}	7×10^{-10}
Technetium (43)	Tc 96m	S	8×10^{-5}	1×10^{-2}	3×10^{-6}
		I	3×10^{-5}	1×10^{-2}	1×10^{-6}
	Tc 96	S	6×10^{-7}	1×10^{-4}	2×10^{-8}
		I	2×10^{-7}	5×10^{-5}	8×10^{-9}
	Tc 97m	S	2×10^{-6}	4×10^{-4}	8×10^{-8}
		I	2×10^{-7}	2×10^{-4}	5×10^{-9}
	Tc 97	S	1×10^{-5}	2×10^{-3}	4×10^{-7}
		I	3×10^{-7}	8×10^{-4}	1×10^{-8}
	Tc 99m	S	4×10^{-5}	[illegible]	[illegible]
		I	1×10^{-5}	3×10^{-3}	5×10^{-7}
	Tc 99	S	2×10^{-6}	3×10^{-4}	7×10^{-8}
		I	6×10^{-8}	2×10^{-4}	2×10^{-9}
Tellurium (52)	Te 125m	S	4×10^{-7}	2×10^{-4}	1×10^{-8}
		I	1×10^{-7}	1×10^{-4}	4×10^{-9}
	Te 127m	S	1×10^{-7}	6×10^{-5}	5×10^{-9}
		I	4×10^{-8}	5×10^{-5}	1×10^{-9}
	Te 127	S	2×10^{-6}	3×10^{-4}	6×10^{-8}
		I	9×10^{-7}	2×10^{-4}	3×10^{-8}
	Te 129m	S	8×10^{-8}	3×10^{-5}	3×10^{-9}
		I	3×10^{-8}	2×10^{-5}	1×10^{-9}
	Te 129	S	5×10^{-6}	8×10^{-4}	2×10^{-7}
		I	4×10^{-6}	8×10^{-4}	1×10^{-7}
	Te 131m	S	4×10^{-7}	6×10^{-5}	1×10^{-8}
		I	2×10^{-7}	4×10^{-5}	6×10^{-9}
	Te 132	S	2×10^{-7}	3×10^{-5}	7×10^{-9}
		I	1×10^{-7}	2×10^{-5}	4×10^{-9}
Terbium (65)	Tb 160	S	1×10^{-7}	4×10^{-5}	3×10^{-9}
		I	3×10^{-8}	4×10^{-5}	1×10^{-9}
Thallium (81)	Tl 200	S	3×10^{-6}	4×10^{-4}	9×10^{-8}
		I	1×10^{-6}	2×10^{-4}	4×10^{-8}
	Tl 201	S	2×10^{-6}	3×10^{-4}	7×10^{-8}
		I	9×10^{-7}	2×10^{-4}	3×10^{-8}
	Tl 202	S	8×10^{-7}	1×10^{-4}	3×10^{-8}
		I	2×10^{-7}	7×10^{-5}	8×10^{-9}
	Tl 204	S	6×10^{-7}	1×10^{-4}	2×10^{-8}
		I	3×10^{-8}	6×10^{-5}	9×10^{-10}
Thorium (90)	Th 227	S	3×10^{-10}	2×10^{-5}	1×10^{-11}
		I	2×10^{-10}	2×10^{-5}	6×10^{-12}
	Th 228	S	9×10^{-12}	7×10^{-6}	3×10^{-13}
		I	6×10^{-12}	1×10^{-5}	2×10^{-13}

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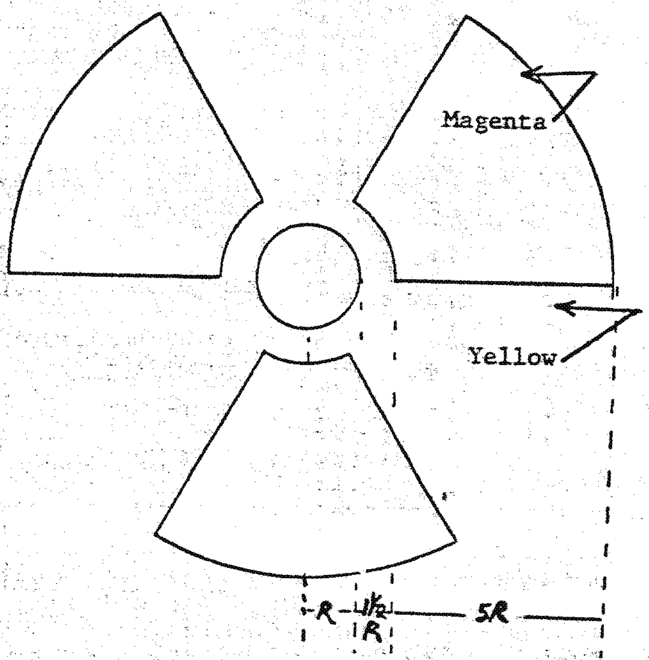
ELEMENT (atomic number)	ISOTOPE[1]		Column 1 AIR (uc/ml)	Column 2 WATER (uc/ml)	Column 3 AIR (uc/ml)
	Th 230	S	2×10^{-12}	2×10^{-6}	8×10^{-14}
		I	1×10^{-11}	3×10^{-5}	3×10^{-13}
	Th 231	S	1×10^{-6}	2×10^{-4}	5×10^{-8}
		I	1×10^{-6}	2×10^{-4}	4×10^{-8}
	Th 232	S	2×10^{-12}	2×10^{-6}	7×10^{-14}
		I	1×10^{-11}	4×10^{-5}	4×10^{-13}
	Th 234	S	6×10^{-8}	2×10^{-5}	2×10^{-9}
		I	3×10^{-8}	2×10^{-5}	1×10^{-9}
	Th natural	S	2×10^{-12}	1×10^{-6}	6×10^{-14}
		I	4×10^{-12}	1×10^{-5}	1×10^{-13}
Thulium (69)	Tm 170	S	4×10^{-8}	5×10^{-5}	1×10^{-9}
		I	3×10^{-8}	5×10^{-5}	1×10^{-9}
	Tm 171	S	1×10^{-7}	5×10^{-4}	4×10^{-9}
		I	2×10^{-7}	5×10^{-4}	8×10^{-9}
Tin (50)	Sn 113	S	4×10^{-7}	9×10^{-5}	1×10^{-8}
		I	5×10^{-8}	8×10^{-5}	2×10^{-9}
	Sn 125	S	1×10^{-7}	2×10^{-5}	4×10^{-9}
		I	8×10^{-8}	2×10^{-5}	3×10^{-9}
Tungsten (Wolfram) (74)	W 181	S	2×10^{-6}	4×10^{-4}	8×10^{-8}
		I	1×10^{-7}	3×10^{-4}	4×10^{-9}
	W 185	S	8×10^{-7}	1×10^{-4}	3×10^{-8}
		I	1×10^{-7}	1×10^{-4}	4×10^{-9}
	W 187	S	4×10^{-7}	7×10^{-5}	2×10^{-8}
		I	3×10^{-7}	6×10^{-5}	1×10^{-8}
Uranium (92)	U 230	S	3×10^{-10}	5×10^{-6}	1×10^{-11}
		I	1×10^{-10}	5×10^{-6}	4×10^{-12}
	U 232	S	1×10^{-10}	3×10^{-5}	3×10^{-12}
		I	3×10^{-11}	3×10^{-5}	9×10^{-13}
	U 233	S	5×10^{-10}	3×10^{-5}	2×10^{-11}
		I	1×10^{-10}	3×10^{-5}	4×10^{-12}
	U 234	S	6×10^{-10}	3×10^{-5}	2×10^{-11}
		I	1×10^{-10}	3×10^{-5}	4×10^{-12}
	U 235	S	5×10^{-10}	3×10^{-5}	2×10^{-11}
		I	1×10^{-10}	3×10^{-5}	4×10^{-12}
	U 236	S	6×10^{-10}	3×10^{-5}	2×10^{-11}
		I	1×10^{-10}	3×10^{-5}	4×10^{-12}
	U 238	S	7×10^{-11}	4×10^{-5}	3×10^{-12}
		I	1×10^{-10}	4×10^{-5}	5×10^{-12}
	U natural	S	7×10^{-11}	2×10^{-5}	3×10^{-12}
		I	6×10^{-11}	2×10^{-5}	2×10^{-12}
Vanadium (23)	V 48	S	2×10^{-7}	3×10^{-5}	6×10^{-9}
		I	6×10^{-8}	3×10^{-5}	2×10^{-9}
Xenon (54)	Xe 131m	Sub	2×10^{-5}	—	4×10^{-7}
	Xe 133	Sub	1×10^{-5}	—	3×10^{-7}
	Xe 135	Sub	4×10^{-6}	—	1×10^{-7}
Ytterbium (70)	Yb 175	S	7×10^{-7}	1×10^{-4}	2×10^{-8}
		I	6×10^{-7}	1×10^{-4}	2×10^{-8}
Yttrium (39)	Y 90	S	1×10^{-7}	2×10^{-5}	4×10^{-9}
		I	1×10^{-7}	2×10^{-5}	3×10^{-9}
	Y 91m	S	2×10^{-5}	3×10^{-3}	8×10^{-7}
		I	2×10^{-5}	3×10^{-3}	6×10^{-7}
	Y 91	S	4×10^{-8}	3×10^{-5}	1×10^{-9}
		I	3×10^{-8}	3×10^{-5}	1×10^{-9}
	Y 92	S	4×10^{-7}	6×10^{-5}	1×10^{-8}
		I	3×10^{-7}	6×10^{-5}	1×10^{-8}
	Y 93	S	2×10^{-7}	3×10^{-5}	6×10^{-9}
		I	1×10^{-7}	3×10^{-5}	5×10^{-9}
Zinc (30)	Zn 65	S	1×10^{-7}	1×10^{-4}	4×10^{-9}
		I	6×10^{-8}	2×10^{-4}	2×10^{-9}
	Zn 69m	S	4×10^{-7}	7×10^{-5}	1×10^{-8}
		I	3×10^{-7}	6×10^{-5}	1×10^{-8}
	Zn 69	S	7×10^{-6}	2×10^{-3}	2×10^{-7}
		I	9×10^{-6}	2×10^{-3}	3×10^{-7}
Zirconium (40)	Zr 93	S	1×10^{-7}	8×10^{-4}	4×10^{-9}
		I	3×10^{-7}	8×10^{-4}	1×10^{-8}
	Zr 95	S	1×10^{-7}	6×10^{-5}	4×10^{-9}
		I	3×10^{-8}	6×10^{-5}	1×10^{-9}
	Zr 97	S	1×10^{-7}	2×10^{-5}	4×10^{-9}
		I	9×10^{-8}	2×10^{-5}	3×10^{-9}

EXPLANATORY NOTE: These concentrations may be modified to conform to recommendations promulgated by recognized and authoritative national and international agencies.

Appendix II
RADIATION SYMBOL



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Historical Note

The 1949 revision substituted "division of health" for "state board of health."

Prior to the 1951 amendment, the opening portion of this section read as follows: "Any person or persons violating, refusing or neglecting to obey the provisions of sections 192.260 to 192.320 or any of the rules and regulations or procedures made by the division of health in accordance with said sections * * *"; and the clause which now reads "or who invades or breaks quarantine" read "or who evades or breaks quarantine".

Section 192.210 was repealed coincident with the 1951 amendment of § 192.320.

The amendment of 1961 substituted "invades" for "evades".

Prior Laws and Revisions:

R.S.1929, § 9030.
R.S.1919, § 5786.
L.1919, p. 374.
R.S.1909, § 6662.
R.S.1899, § 7529.
R.S.1889, § 5434.
L.1883, p. 98, § 18.

Library References

Health ⟹37.

C.J.S. Health § 29 et seq.

RADIATION CONTROL

192.400. Definitions

The following words and terms as used in sections 192.400 to 192.490 mean:

(1) "Committee on Radiation Control", a subcommittee of the Missouri Atomic Energy Commission;

(2) "Radiation", any or all of the following forms of ionizing radiation: gamma and X rays, alpha and beta particles, high speed electrons, neutrons, protons and other nuclear or atomic particles or rays, and other radiant energies including, by way of extension but not of limitation, radium, strontium 90, cesium 137 and cobalt 60, but radiation as herein defined does not include sound or radio waves or visible, infrared or ultraviolet light;

(3) "Radiation machine", any device that produces radiation;

(4) "Unnecessary radiation", the use of radiation as herein defined in such a manner as to be hazardous to the health of the people or the industrial or agricultural potentials of the state. (L.1963 p. 359 § 1)

Historical Note

Title of Act:

An Act relating to radiation protection and control, creating a committee on radiation control and prescribing functions, powers and duties relating to prevention and prohibition of unnecessary radiation and providing a penalty for violation of provisions of this act. Laws 1963, p. 359.

Cross References

Atomic energy commission generally, see § 324.010 et seq.
Southern interstate nuclear compact adopted, see § 324.060.

Library References

Health 🔑6. C.J.S. Health § 9 et seq.

192.410. Powers and duties of division

The division of health, with the guidance and advice of the committee on radiation, shall

(1) Develop comprehensive policies and programs for the evaluation and determination of hazards associated with the use of radiation and for their abatement or elimination;

(2) Employ, and, if necessary, train the personnel needed to carry out the provisions of sections 192.400 to 192.490;

(3) Advise, consult and cooperate with other agencies of this state, the federal government, other states, and interstate agencies, and with affected groups, political subdivisions and industries in furtherance of the purposes of sections 192.400 to 192.490;

(4) Accept and administer loans, grants or other funds or gifts from the federal government and from other sources, public or private, for carrying out any of its functions;

(5) Encourage, participate in or conduct studies, investigations, training, research and demonstrations relating to the control of radiation hazards, the measurement of radiation, the effects on health of exposure to radiation and related problems as it may deem necessary or advisable for the discharge of its duties under sections 192.400 to 192.490 or for the protection of public health;

(6) Collect and disseminate information relating to the determination and control of radiation exposure and hazards;

(7) Review and approve plans and specifications for radiation sources submitted pursuant to rules and regulations promulgated under sections 192.400 to 192.490;

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(8) Inspect radiation sources, their shielding and immediate surroundings and records for the determination of any possible radiation hazard and may examine any records or memoranda pertaining to the question of radiation machines and the use of radioactive materials.

(L.1963 p. 359 § 2)

Cross References

Atomic energy commission,
Assistance from other agencies, see § 324.040.
Duties and powers, see § 324.030.
Federal grants for public health work, see 42 U.S.C.A. § 246.

Library References

Health ⟹6. C.J.S. Health § 9 et seq.

192.420. Division to make rules—hearing—notice

1. The division of health shall administer sections 192.400 to 192.490 and may, with the approval of the committee on radiation control, formulate and promulgate rules on radiation, including registration of radiation sources and machines, as may be necessary to prohibit and prevent unnecessary radiation.

2. No rule or regulation shall be adopted except after a public hearing to be held after ten days prior notice by public advertisement of the date, time and place of the hearing and opportunity given to the public to be heard.

3. No rule or regulation shall become effective until thirty days after its adoption and persons heard at the public hearing given written notice of the determination made by the division of health.

(L.1963 p. 359 § 3)

Library References

Health ⟹20. C.J.S. Health §§ 2, 9 et seq.

192.430. Radiation sources to be kept safe

All sources of radiation shall be shielded, transported, handled, used and kept so as to prevent all users thereof and all persons within effective range of them from being exposed to unnecessary radiation.

(L.1963 p. 359 § 4)

Library References

Health ⟹28. C.J.S. Health § 21.

192.440. Unregistered use or possession of radiation producers unlawful—use or possession contrary to law or regulations unlawful

1. It is unlawful for any person to produce radiation, or produce, use, store or dispose of radioactive materials or radiation machines, or to modify, extend or alter these activities unless he registers in writing with the division of health in accordance with the procedures prescribed by the division, except that the division may exempt from registration certain classes of radiation machines or radioactive materials known to be without hazard.

2. It is unlawful for any person to produce radiation, or to produce, use, store or dispose of radioactive materials or radiation machines except in accordance with sections 192.400 to 192.490 and the rules and regulations adopted pursuant to these sections.

(L.1963 p. 359 § 5)

Library References

Health ⇐28. C.J.S. Health § 21.

192.450. Division to order abatement of violations—agents may inspect—data confidential

1. Whenever the division of health finds, upon inspection and examination of a source of radiation as constructed, operated or maintained, that there is a violation of any of the provisions of sections 192.400 to 192.490 or of any of the rules or regulations promulgated under these sections, the division shall notify the person found to be causing, allowing or permitting the violation of the nature of the violation and order that prior to a time fixed by the division, which time shall not be later than thirty days from the date of service of the notice, the person shall cease and abate causing, allowing or permitting the violation and to take such action as is necessary to comply with sections 192.400 to 192.490 and the rules or regulations promulgated under these sections.

2. Agents of the division of health charged with the enforcement of the provisions of sections 192.400 to 192.490 have the right of entry and free access at reasonable times to any building or structure for the purposes of inspection and examination.

3. All data obtained as a result of registration, inspection or investigation shall be kept confidential by the division.

(L.1963 p. 359 § 6)

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Cross References

Unreasonable search and seizure, prohibited, see Const. art. 1, § 15.

Library References

Health ⟹13.	C.J.S. Health § 21 et seq.

192.460. Emergency orders—compliance required—hearing

Whenever the division of health finds that an emergency exists requiring immediate action to protect the public health or welfare, it may issue an order reciting the existence of an emergency and requiring that such action be taken as it deems necessary to meet the emergency. The order shall be effective immediately. Any person to whom the order is directed shall comply therewith immediately, but on application to the division shall be afforded a hearing within ten days. On the basis of the hearing the division shall continue such order in effect, revoke it, or modify it.

(L.1963 p. 359 § 7)

Library References

Health ⟹9 et seq.	C.J.S. Health § 11.

192.470. Judicial review

Any person aggrieved by any finding or order of the division under sections 192.400 to 192.490 may appeal as provided in chapter 536, RSMo.

(L.1963 p. 359 § 8)

Cross References

Review of administrative findings or orders, see V.A.M.R., rule 100.01 et seq.

Library References

Health ⟹9.	C.J.S. Health § 11.

192.480. Law not to limit medical use of radiation

Nothing in sections 192.400 to 192.490 is interpreted as limiting intentional exposure of persons to radiation for the purpose of diagnosis or therapy, or medical research, as authorized by law.

(L.1963 p. 359 § 9)

Library References

Health ⟹28.	C.J.S. Health § 21.

192.490. Violation of law or regulation, misdemeanor—injunctive relief

1. Any person who violates any of the provisions of, or fails to perform any duty imposed by, sections 192.400 to 192.490, or who violates any rule or regulation of the division of health promulgated pursuant to sections 192.400 to 192.490, is guilty of a misdemeanor and, in addition, may be enjoined in a civil action by a court of competent jurisdiction from continuing the violation.

2. Each day upon which the violation occurs constitutes a separate violation.

3. The attorney general, on request of the division of health, shall bring an action for injunctive relief to prevent the violation of the provisions of sections 192.400 to 192.490 or rules or regulations promulgated under these sections.

(L.1963 p. 359 § 10)

Cross References

Attorney general's duties, see § 27.030 et seq.
Injunctions, generally, see § 526.010 et seq.; V.A.M.R., rule 92.01 et seq.

Library References

Health ⇐37.
Injunction ⇐89(2).
C.J.S. Health § 29 et seq.
C.J.S. Injunctions § 123 et seq.

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METROPOLITAN ST. LOUIS SEWER DISTRICT
INDUSTRIAL WASTE DIVISION
ROUTE SLIP

	Recipient	Init.	Date
1	MANAGER	[illegible]	2/6/81
	ASST.MANAGER		
	LAB SUPERVISOR		
	ENGINEER(Field)		
	ENGINEER(Admin.)		
	SECRETARY		
	TYPIST CLERK II		
	FILE:		

ACTION:

ENVIRONMENTAL PROTECTION AGENCY

40 CFR Part 192

[AH-FRL 1610-4]

Proposed Disposal Standards for Inactive Uranium Processing Sites; Invitation for Comment

AGENCY: U.S. Environmental Protection Agency.

ACTION: Proposed rule and extension of comment period.

SUMMARY: The Environmental Protection Agency (EPA) requests comments on proposed standards for disposal of residual radioactive materials (mainly tailings) from inactive uranium processing sites. EPA has developed these standards pursuant to Section 275(a) of the Atomic Energy Act, 42 U.S.C. Section 2022(a), as added by Section 206(a) of PL 95-604, the Uranium Mill Tailings Radiation Control Act of 1978. PL 95-604 requires the Department of Energy to conduct remedial actions for designated inactive uranium processing sites in accordance with standards promulgated by EPA.

The proposed standards apply to disposal of tailings which qualify for remedial actions under Title I of PL 95-604, and set limits on their radon release to the atmosphere and on water contamination. The standards also require tailings to be disposed of in a way that provides a reasonable expectation that these limits will be satisfied for at least one thousand years.

We have already proposed standards for the cleanup of open lands and buildings contaminated with residual radioactive materials from inactive uranium processing sites (45 FR 27370-27375, April 22, 1980). The cleanup standards were also made immediately effective as interim standards pending public review and promulgation of final standards (45 FR 27366-27368, April 22, 1980). We are hereby extending the comment period for the cleanup standards we proposed earlier so that it will coincide with the comment period for the disposal standards.

Additional background material for the proposed cleanup and disposal standards is given in a Draft Environmental Impact Statement (EIS) that EPA is issuing. Copies of an earlier version of the draft EIS were placed in the Docket and in Reading Rooms at EPA's Regional Offices when the cleanup standards were published. In addition to this request for written comments, the Agency will shortly announce the time and place of hearings at which interested persons may present comments on both the previously proposed cleanup standards and these disposal standards.

DATE: Comments on both the cleanup standards and the disposal standards should be received on or before May 11, 1981.

ADDRESS: Comments on the proposed cleanup and disposal standards should be submitted to Docket No. A-79-25, which is located in the Environmental Protection Agency, Central Docket Section, West Tower Lobby, 401 M Street SW., Washington, D.C. 20460. Single copies of the Draft Environmental Impact Statement (EPA Report 520/4-80-011) may be obtained by writing to the address given below.

FOR FURTHER INFORMATION CONTACT: Dr. Stanley Lichtman, Criteria & Standards Division (ANR-460), Office of Radiation Programs, U.S. Environmental Protection Agency, Washington, D.C. 20460; telephone number 703-557-8927.

SUPPLEMENTARY INFORMATION:

I. Introduction

The proposed standards were developed by EPA at the direction of Congress in order to protect public health, safety, and the environment from uranium mill tailings produced at processing sites which are now inactive. There are two major parts of the remedial actions necessary for this protection: cleanup and disposal. The cleanup process reduces the potential health consequences of tailings which have been dispersed from their original location on a tailings pile or used in construction. Disposal is the operation which places the tailings themselves in a condition which will be safe for a long time. The disposal site may be at the original location of the tailings, or a new one. Standards are proposed here for the disposal aspects of the remedial actions.[1]

In order to carry out our responsibility under PL 95-604 to set generally applicable standards for uranium mill tailings, we have examined their potential public health and environmental impacts. This examination established the radiological and nonradiological characteristics of tailings which require control.

Tailings are hazardous primarily because: 1) breathing radon and its decay products exposes the lungs to alpha particles; 2) the body may be exposed to gamma rays; 3) radioactive materials and nonradioactive toxic elements from tailings may be swallowed with food and water. The radiation hazard from tailings lasts for many thousands of years, and nonradioactive toxic elements persist indefinitely. The longevity of these hazards played a major role in determining the proposed standards.

Although the available data are consistent with many models, we believe that a linear, nonthreshold dose-effect relationship is a reasonable basis for deriving estimates of radiation risk to the general public and for establishing regulations. This model assumes that any radiation dose presents some risk to humans and that the risk of low doses is directly proportional to the risk demonstrated at higher doses. We recognize, however, that the data preclude neither a threshold for some types of radiation below which there is no damage to people, nor the possibility that low doses may do more damage to people than the linear model implies.

The alpha particles from inhaled radon decay products can cause lung cancer. Also, gamma rays can cause cancers, teratogenic effects, and genetic damage. Our health risk estimates are based on our review of epidemiological studies conducted in the United States and other countries of underground miners of uranium and other metals who have been exposed to radon decay products, and on three reports: *The Effects on Population of Exposure to Low Levels of Ionizing Radiation* (1972) *Health Effects of Alpha Emitting Particles in the Respiratory Tract* (1976) by the Advisory Committee on the Biological Effects of Ionizing Radiation of the National Academy of Sciences (the BEIR Committee), and the report of the United Nations Scientific Committee on the Effects of Atomic Radiation entitled *Sources and Effects of Ionizing Radiation* (1977). Details of our risk estimates are provided in *Indoor Radiation Exposure Due to Radium-226*

[1] The cleanup standards (Subpart B and Subpart C) were proposed earlier (45 FR 27370-27375, April 22, 1980), and simultaneously also were declared immediately effective as interim standards (45 FR 27366-27368, April 22, 1980). We issued interim cleanup standards in order to have standards in effect as soon as possible, because some buildings have been found where tailings are causing radiation levels that are very hazardous to anyone exposed to them for long times. Public Law 95-604 precludes undertaking remedial action before EPA has promulgated standards. The interim cleanup standards permit the Department of Energy to clean up open lands and buildings under PL 95-604 to alleviate these problems. In addition to having issued interim cleanup standards, however, we are following the public review process contemplated by PL 95-604 for promulgating final cleanup standards.

In this notice we propose disposal standards and invite the public to comment on them. For the convenience of the reader, we are restating here some background material from our earlier notice proposing cleanup standards.

in Florida Phosphate Lands (EPA 520/4–78–013) and in the Draft Environmental Impact Statements (EIS) (EPA 520/4–80–011).

Data from studies of underground miners lead to uncertain risk estimates for exposure to radon and its decay products. This uncertainty is increased when the data are used to estimate the risk to the general population. Nevertheless, we believe the information is sufficient to give a basis for public health standards. For gamma ray exposure standards the data base is very large and good, but again involves extrapolation for application to tailings.

Oftentimes it is not possible to remove all the risk to people exposed to radiation or many other hazardous materials. In deciding how much we should attempt to reduce the risk, we considered the longevity, efficacy, and costs of remedial actions for uranium mill tailings as well as the level of risk. We also considered things which are not easily quantified, such as equity of risk distribution, and administrative difficulties. Finally, we considered the overall implementation costs and protection offered by alternative standards to determine those which are most reasonable.

EPA's mandate is to set standards which apply to any site and method of control. Therefore, our analyses of technology, costs, risk, and other pertinent factors emphasize the general characteristics of uranium mill tailings and their control. The law gives other agencies of Government the authority to decide how these standards will be satisfied at specific locations. They will issue site-specific Environmental Impact Statements where they are required under the National Environmental Policy Act, or an Environmental Assessment will be prepared to determine whether such an EIS is required.

The information, reasoning, and judgments which lead us to issue these particular proposed disposal standards for tailings piles at inactive uranium processing sites are summarized below. Additional background information and more complete presentations of our reasoning and judgments are given in the Draft Environmental Impact Statement.

II. Disposal of Tailings

In PL 95–604, the Congress stated its findings that tailings ". . . may pose a potential and significant radiation health hazard to the public, . . . and . . . that every reasonable effort should be made to provide for stabilization, disposal, and control in a safe and environmentally sound manner of such tailings in order to prevent or minimize radon diffusion into the environment and to prevent or minimize other environmental hazards from such tailings." The Environmental Protection Agency was directed by Congress to set ". . . standards of general application for the protection of the public health, safety, and the environment . . ." for such materials. The legislative record also shows Congress intended that these standards not be site-specific.

The Committee report on the Uranium Mill Tailings Radiation Control Act expressed the intention that the technologies used for remedial actions should not be effective for only a short period of time. "The Committee does not want to visit this problem again with additional aid. The remedial action must be done right the first time," it stated (H.R. Rep. No. 1480, 95th Cong., 2nd Sess., page 40(1978)). Our proposed disposal standards are meant to ensure this long-lasting solution for those tailings piles at inactive processing sites that are covered by PL 95–604.

Pathways and Health Effects

Uranium mill tailings can effect people's health through four basic pathways. These are:

1. *Diffusion of radon-222, the noble gas decay product of radium-226, from the tailings to the air.* Breathing radon-222 and its short half-life decay products (principally polonium-218, bismuth-214, and polonium-214) exposes the lungs to alpha particles. Smaller additional doses to the lungs and other organs result from swallowing and breathing the long-lived radon-222 decay products (lead-210 and polonium-210).

2. *Small particles of tailings material in the air.* Wind erosion of unstabilized tailings piles results in airborne tailings material. Intake of thorium-230, radium-226, and lead-210 are the principal concerns from this pathway. The predominant doses are to the lungs from breathing these radionuclides and to the bones from eating foods containing them.

3. *Waterborne material.* Both wind and water flowing over or through the tailings can carry radioactive and other toxic materials to bodies of water. This could cause long-term contamination of surface and underground water, and human intake of toxic substances.

4. *External gamma radiation exposure from tailings.* A tailings pile emits gamma radiation, since many of the radioactive nuclei in it produce gamma rays along with their other decay products. The most important gamma emitters are lead-214 and bismuth-214.

The increase in cancer possibly caused by airborne substances from a pile can be estimated reasonably well by using general environmental transport models. However, the levels of waterborne contaminants and their effects are highly site-specific and we can only discuss them in general. The possible effects of direct gamma radiation from the piles are easy to estimate. They are small, except very close to the tailings piles.

EPA's analysis of the exposure pathways for uranium mill tailings piles relies on existing information provided by NRC and DOE and their contractors, and on earlier studies by EPA. [2] To significantly enhance this knowledge would require several years of intensive investigation. We believe this is unnecessary and that such a delay in promulgating standards would not be in the public interest.

Radiation Effects from Air Pathways

Based on the current U.S. population, we estimated the air-transmitted hazards of uranium mill tailings piles for people close to the pile (within several miles), in the surrounding region (within 50 miles, but not "close to the pile"), and in the remainder of the nation. Four sources of exposure were considered: inhaled short-lived radon decay products, the most important source of potential cancers; the long-lived radon decay products, principally lead-210; airborne tailings; and direct gamma radiation. Estimating the risk from exposure to the short-lived radon decay products and the gamma radiation is relatively straightforward. However, the pathways and dose calculations for long-lived radon decay products and airborne tailings depend very heavily on assumptions about the use and preparation of locally grown foodstuffs. Dose estimates for these pathways are given in the NRC Draft Generic Environmental Impact Statement on Uranium Milling (DGEIS). These estimates are likely to be high because of the assumptions made in regard to local foods. Nevertheless, the risks are small compared with those due to the short-lived radon decay products.

From our analysis we conclude:

1. Lung cancer caused by radon's short-lived decay products is the dominant radiation hazard from untreated uranium mill tailings piles on local, regional, and national scales. Effects of long-lived radon decay

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[2] We analyzed 22 of the 25 tailings piles at inactive processing sites DOE has designated for remedial actions under PL 95–604. The other 3 piles were determined to be eligible for remedial actions only after our assessment was nearly completed. However, based on general descriptions of the 3 piles, we believe that including them in the assessment would not cause us to change our proposals for disposal standards that apply to all the designated sites.

products, of windblown tailings, and of direct gamma radiation from the piles are much less significant.

2. Individuals near a pile bear much higher radiation risks than those far away. For example, we estimate that individuals living continuously one mile from a large pile would have about 200 times as great a chance of a fatal lung cancer caused by radon decay products as persons living 20 miles away (7 in 10,000 versus 3 in 1,000,000). People even closer to some of the piles at inactive processing sites bear increased lifetime lung cancer risks as high as 4 chances in 100.

3. The total number of cancer deaths estimated to be caused by a uranium mill tailings pile depends strongly on the size and locations of the local populations.

4. Based on present population data, all the 22 piles at inactive sites we studied, taken together, may cause about 40 to 90 deaths from lung cancer per century among persons living 50 miles or more away from a pile. When local and regional rates are added to these, the estimated total national effect of all the 22 piles is about 200 premature deaths from lung cancer per century; i.e., about 2 deaths each year.

Part of the uncertainty in these estimates is due to necessary approximations in estimating the environmental radiation levels a tailings pile produces, and what dose people will receive. Additional uncertainty comes from our incomplete knowledge of the effects on people of these generally low exposures.

Our estimates are based upon current population sizes and geographical distributions. Overall increases in national population would raise the estimated national effects in approximate proportion. Development of new population centers near currently remote piles, and substantial growth of cities already near one, would increase these estimates proportionately to this growth.

Water Pathways

The water-transmitted hazards of uranium mill tailings are due both to radionuclides and to nonradioactive toxic substances, such as arsenic, lead, selenium, and molybdenum. Uranium, thorium, radium, and nonradioactive toxic substances can contaminate water resources and affect crops, animals, and people. A theoretical analysis of a model pile performed for NRC's DGEIS on Uranium Milling showed that ground water contamination by selenium, sulfate, manganese, and iron might exceed current drinking water standards over an area 2 kilometers wide and 8 to 30 kilometers long.

Tailing piles at inactive mill sites already have lost much of the water deposited in them during mill operation. The water evaporated, went underground, or ran out on the surface. Any future water contamination by the pile would be from erosion, rain, snow, or flooding. The quality of streams and lakes could be degraded by contaminated seepage from a pile, or by tailings which are carried to them by wind or water.

The movement of contaminants to ground water depends on a combination of complex chemical and physical properties of the underground environment, and on conditions such as precipitation and evaporation. Chemical and physical processes in the subsoil partly remove contaminants from water passing through it. However, some contaminants, such as selenium, arsenic, and molybdenum, can occur in forms which are not removed.

Future ground water contamination could be caused by either past or future releases of toxic substances from the piles. These substances are likely to move slowly through the ground. Ground water itself can move more slowly than a few feet per year, and only in coarse or cracked materials does the speed exceed one mile per year. For these reasons, pollutants from tailings may not affect the quality of nearby water supply wells for decades or longer after they are released. However, once polluted, the quality of such water supplies can not be quickly restored by eliminating the source. Even if a pile is covered so that there is no further run-off or seepage, it may take longer to restore the original water quality throughout the affected area than the time from the start of the pile to the first contamination of water supplies.

In the draft EIS for these proposed standards, we review the health problems that could arise from using water containing nonradioactive toxic substances from uranium mill tailings.

Control of Tailing Piles

The objectives of tailings disposal should be to control harmful substances so as to avoid their spread to the general environment and to people. The longevity or permanence of control methods is of prime concern. Because of the long lifetimes of the radioactive contaminants (thorium-230, for example, has a half-life [3] of about 80,000 years) and the presence of other toxic chemicals (which never decay), the potential for harming people will persist indefinitely. Many interrelated factors affect the long-term performance of tailings pile disposal methods. They include external natural phenomena, such as earthquakes, floods, windstorms, and glaciers, internal chemical and mechanical processes, and human activities. Predicitions of the stability of the piles become less certain as the time period increases. Beyond several thousand years, long-term geological processes and climatic change will determine the effectiveness of most "permanent" control methods.

Attempts to stabilize tailings piles at inactive sites by applying thin covers on them have had only limited and short-term control objectives, but the growing awareness of the hazards of tailings and passage of PL 95–604 in 1978 have led to increasing research on effective long-term control methods. Although several States and the NRC have begun regulating tailings at active mills, no disposal method has been tested sufficiently to establish its practicality or effectiveness over long periods of time. However, we believe the basic principles of effective long-term control methods are understood.

Radon release control methods range from a simple barrier between the tailings and the atmosphere to such ambitious treatments as embedding tailings in cement or processing them to remove the radon sources. Covering the tailings with permeable barriers, such as soil, slows down the radon passing through; less is released because some of the radon decays before it gets to the air. The more permeable the covering material, the thicker it must be for a given reduction in radon release. Maintaining the integrity of thin impermeable covers, such as plastic sheets, over periods as short as tens to hundreds of years, however, is highly uncertain under the likely range of chemical and physical stresses.

Methods that control radon (a gas) will also prevent releases of tailings particulates to the air or to surface water.[4] Similarly, permeable covers sufficiently thick for effective radon control will also absorb gamma radiation very well (although thin impermeable covers will not). Disruptions of the tailings by streams, floods, wind, or rain can be delayed by contouring the pile and its cover, and by

[3] A half-life is the time it takes for a given quantity of a radioactive isotope to decay to half that quantity.

[4] However, recent studies suggest that some processes occurring in tailings piles tend to carry dissolved contaminants upward, perhaps even through soil coverings. Disposal system designers must carefully consider this possibility. The Department of Energy currently is intensively investigating a variety of disposal methods.

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stabilizing the surface (with stones, for example) to make it resistant to erosion. If necessary, erosion can be delayed by burying the tailings pile in a shallow pit or moving it away from a flood-prone or otherwise problematic site.

As an alternative to covering tailings on or just below the Earth's surface, nearly complete long-term control of contaminant releases to air and surface water could be achieved by burying them in deep mined cavities. In most cases, however, direct contact with ground water would be difficult to avoid. The potential hazards of tailings could also be reduced by chemically processing them to remove contaminants. Such processes have limited efficiencies, however, so the residual tailings would still require careful disposal. Furthermore, the extracted substances, radium and thorium, for example, would be concentrated and perhaps even more hazardous than before.

In the draft EIS we analyze the health and environmental protection benefits and the costs of several levels of controlling tailings, assuming a variety of potential control methods. We find that radon emission levels of an "average" pile can be reduced to approximately the levels characteristic of ordinary land by applying a soil cover at costs in a range of about 1 to 14 million (1979) dollars. The cost does not depend much on the degree of radon reduction. Rather, the range of costs mainly reflects the choices of materials for stabilizing the surface, the possible need for specific water protection features, and transportation and site preparation costs if a new site is needed. We estimate the costs for deep disposal to be about 8 to 63 million (1979) dolloars; the lowest estimate assumes the availability of a suitable open-pit mine close to the tailings pile and other favorable circumstances. Disposal using chemical processing to extract radium and perhaps other substances would cost approximately 78 million (1979) dollars per pile.

Selection of Proposed Disposal Standards

Proposed Radon Emission Standards

From several perspectives, we find it reasonable to reduce radon emission rates from tailings at inactive processing sites from their current values of several hundred pCi/m^2 sec [5] to a range more characteristic of natural emission rates from ordinary land. Typical natural emission rates are from 0.5 to 1 pCi/m^2-sec, with variations up to several times these values not unusual.

After considering the alternatives, we have concluded that the numerical limit on pile emissions, following disposal, should be chosen in a range of about 0.5 to 2.0 pCi/m^2-sec. When this emission rate is added to that of a normal earth covering, the disposal site emission rate would still be within natural variations.

Several analyses [6] of controlling radon emission by covering piles with soil suggest that the required covering thickness rises sharply [7] near an emmision rate of about 1 pCi/m^2-sec. However, there has been no opportunity to test these analyses against full-scale field experience. If soil coverings should be less efficient in controlling radon than the analyses indicate, achieving a standard at the low end of the range could be much more difficult and expensive than we estimate. Yet, the health benefit so gained would be marginal. We therefore propose an allowed tailings emission rate of 2 pCi/m^2-sec, rather than a slightly lower figure, to allow for more technical flexibility in implementing the standards.

Higher control levels, say 10–40 pCi/m^2-sec, appear unjustified, because emission rates of that size can be lowered to 2 pCi/m^2-sec for about 10% additional cost.[8] With such elevated radon emissions, the probable need for land-use restrictions adjacent to the disposal site would place a continuing administrative burden on future generations.

We also find almost total control of radon release from the tailings unjustified. Incremental costs for achieving long-term emission rates lower than 2 pCi/m^2-sec rise rapidly relative to radon emission reduction and any health benefits that might be achieved. There is no need to restrict the use of land near the disposal site because of radon releases from the tailings for emission rates near 2 pCi/m^2-sec. We have not found any administrative or aesthetic advantages in further reductions.

We believe our approach is appropriate for the new and large-scale undertaking of tailing disposal. Typically, the proposed standard would reduce radon emissions and their possible effects by 99%. Measures that will cut down radon emissions this much for at least 1000 years (see below) will also eliminate blown tailings and excess gamma radiation. Therefore, implementing the radon control standard will virtually eliminate all the potential hazards except water pollution.

Proposed Ground Water Protection Standards

The proposed ground water protection standards provide that after tailings piles are disposed of the piles will not cause ground water concentrations of selected contaminants to exceed specified levels. We chose levels we believe are adequate to protect good quality ground water for direct human consumption and for a wide variety of other purposes. If upstream ground water already exceeds the specified concentration levels for causes other than tailings, then no further degradation is allowed.

Except as noted below, the specified concentration levels are the same as the maximum contaminant levels of the National Interim Primary Drinking Water Regulations (NIPDWR). We use these levels quite differently here, however, and our standards have no legal tie to the NIPDWR. Though fluoride levels are given in the NIPDWR, we are omitting them from the proposed standards because fluorides are not important constituents of tailings. Levels for molybdenum and uranium are not given in the NIPDWR, but we believe they are needed because of the abundance of these substances in tailings, their toxicity, and their likely mobility in ground water. We selected the proposed molybdenum level on the basis of avoiding toxic effects in humans. The proposed uranium level is the one for which our estimate of bone cancer risk is about the same as the estimated bone cancer risk from radium under the NIPDWR.

The contaminants we include in the proposed ground water standard cover the most hazardous tailings substances. Conditions that control these toxic substances will also control many other substances. We do not wish to complicate the task of demonstrating compliance with the standard by including nonessential requirements, such as a much-expanded list of covered contaminants. It is in this same spirit that we are proposing to allow minimal degradation of very good quality water. There is no clear need for stricter standards than we are proposing, and substantial additional resources could be required to meet them for some piles.

[5] pCi/m^2-sec stands for picocuries per square meter per second, a measure of the release rate of radioactivity from a surface. A curie is the amount of radioactive material that produces 37 billion nuclear transformations per second. A picocurie is a trillionth of a curie. One picocurie produces a little more than two nuclear transformations per minute.

[6] These studies are cited in the draft EIS.

[7] Reducing the emission rate from 10 to 9 pCi/m^2-sec (a 10% reduction) requires about 1 cm of added soil; the same size reduction from 2 to 1 pCi/m^2-sec (50%) takes about 50 cm of added soil.

[8] This assumes that covering the tailings with soils and clay is a feasible method for radon control to an emission rate of about 2 pCi/m^2-sec.

There is evidence of limited ground water contamination at some of the inactive sites, but the prospects for long-term contamination have not been fully assessed. The proposed ground water protection standards, however, apply only to releases from tailings that may occur after disposal of the piles. It may sometimes be possible to improve the quality of an already-contaminated aquifer, but we believe a generally applicable requirement to meet pre-set standards is not feasible.

The Department of Energy will prepare Environmental Impact Statements or Environmental Assessment reports for each site to support the decisions it will reach, with NRC's concurrence, on necessary remedial action to satisfy the standards. We believe that disposal methods that satisfy the standards will avoid ground water problems caused by future releases from the piles for at least 1000 years (see below). We expect DOE to consider the need for and practicality of controlling contaminants that have already seeped under the tailings pile, and to apply technical remedies that are found justified. Institutional controls should also be applied, however. If tailings are found to be contaminating ground water that is being used, we would expect DOE to provide alternate water sources or other appropriate remedies. We note that PL 95–604 will terminate DOE's authority to do so as a remedial action seven years after we promulgate standards, unless Congress extends the period. However, PL 95–604 provides for Federal custody of the disposal sites under NRC licenses after the remedial action program is completed. The custodial agency is authorized to carry out such monitoring, maintenance, and emergency measures as the NRC may deem necessary to protect public health. We expect NRC's monitoring requirements will be sufficient to ensure detection of any contamination by the tailings of usable ground water near the disposal sites, and to cause the custodial agency to take necessary measures to avoid any significant public health problem.

The actions necessary to avoid future ground water contamination may increase disposal costs in some cases up to double the cost of radon control alone. Available information suggests that such measures often will not be needed because many tailings piles do not threaten ground water. Moreover, where the standards might be exceeded only in the immediate neighborhood of a pile, we do not believe the substantial costs and disruptions necessary to avoid the violation would be warranted. Therefore, when existing tailings sites are used for disposal, we propose that the ground water protection standards be applied 1.0 kilometer from the pile. If tailings are moved to a new disposal site for any reason, then site selection and preparation are possible. We propose that the standard for a new site be applied 0.1 kilometer from the pile.

EPA is developing a ground water protection strategy which, to the extent that various legislative authorities allow and it is practicable, will guide the development of consistent regulations for a number of its programs. These include programs for disposal of solid wastes under the Resource Conservation and Recovery Act, underground injection control under the Safe Drinking Water Act, wastewater sludge disposal under the Clean Water Act, and disposal of uranium mill tailings under the Uranium Mill Tailings Radiation Control Act. Persons wishing to comment on this issue (consistency) should refer to EPA's notice (45 FR 66816–23, October 8, 1980) discussing various approaches for protecting ground water from hazardous wastes at land disposal sites covered under Subtitle C of the Resource Conservation and Recovery Act.

We would be pleased to receive suggestions for alternative formulations of ground water standards for disposal of uranium mill tailings covered by Title I of PL 95–604. Should the standard contain limits on allowed degradation, or should it specify nondegradation (no increases in concentrations), or no releases? If degradation limits are used, as we propose, in what other ways might they be determined? Should the standards apply at different distances from the tailings for new disposal sites than for existing sites? What should these distances be? Are more substances needed in the list of covered contaminants, or are any of them superfluous? Comments on these issues will be most useful when supported by reasons and data.

Proposed Surface Water Protection Standards

Wind, rain, or floods can carry tailings into rivers, lakes, and reservoirs. Pollutants may also seep out of the piles and contaminate surface waters. However, implementing the radon emission limits and the ground water protection requirements will greatly reduce this. A pile with severely restricted radon releases will not be able to release particulates to wind or water. Similarly, the ground water protection requirements imply limited water flow through the pile, which limits flow to the surface as well as under the ground. Thus, we expect that the radon emission and ground water standards will protect surface water. However, to assure adequate protection, we propose to require that surface water not be degraded by tailings after disposal of the piles. This means that after disposal, any contaminant releases from the disposal site should not increase the concentration of any harmful substances in surface water.

Longevity of Disposal Standards

Congress recognized that uranium mill tailings are hazardous for a long time, and directed EPA to set reasonable standards for their long-term disposal. We propose requiring a reasonable expectation that the radon emission and water protection standards for disposal of tailings piles will be satisfied for at least 1,000 years.

Institutional control methods such as recordkeeping, maintenance, monitoring, and land-use restrictions are useful adjuncts to an adequate disposal system, to provide greater protection than the standards require, and to regulate deliberate disruptions of the tailings by people.[9] However, we do not believe they should be relied upon for periods longer than a century, and are inappropriate for long-term control. They should not replace use of adequate long-term physical disposal methods.

The choice of a 1,000-year period of application results from practical considerations. Based on existing knowledge of control methods and natural processes, we believe it unreasonable to *generally* require longer protection under this remedial action program, because adequate methods for demonstrating compliance are not clearly available and may be very costly. We consider it likely, however, that the implementers of the standards will require longer protection at some piles, based on site-specific evaluations of disposal methods and their costs.

We believe 1,000 years meets the Congressional criterion that "the remedial action must be done right the first time." This does not mean our concern for the future is limited to 1,000 years, but does reflect our judgment that the remedial actions must be practical. We would be pleased to receive comments on whether 1,000 years is the best choice.

[9] For example, Sec. 104(h) of PL 95–604 anticipates that subsurface minerals at a tailings disposal site may be used. However, it provides that any tailings disturbed by such use "will be restored to a safe and environmentally sound condition." Therefore, we propose to apply the disposal standards to the use of any subsurface mineral rights acquired under the provisions of Sec. 104(h).

III. Implementation

PL 95–604 requires the Secretary of Energy to select and perform remedial actions for uranium mill tailings from inactive processing sites in accordance with EPA's standards, with the full participation of any State that shares the cost. Remedial actions will be selected and performed with the concurrence of the Nuclear Regulatory Commission and in consultation, as appropriate, with affected Indian tribes and the Secretary of the Interior. The costs of the remedial actions will be borne by the Federal Government and the States as prescribed by law.

The disposal standards will be implemented by showing that the disposal method provides a reasonable expectation of satisfying the radon emission limits and water protection provisions of the standards for at least 1,000 years. We intend for this expectation to be founded upon analyses of the physical properties of the disposal system and the potential effects of natural processes over time. Computational models, theories, and expert judgment will be major tools in deciding that a proposed disposal system will satisfy the standard. Post-disposal monitoring can serve only a minor role in confirming that the standards are satisfied. Where measurements are necessary to determining compliance, they may be performed within the accuracy of available field and laboratory instruments used in conjunction with reasonable survey and sampling procedures.

Disposal of tailings piles from inactive processing facilities is a large scale undertaking for which there is very little experience. Although preliminary engineering assessments for the sites affected by these standards have been performed, specific engineering requirements and costs to meet the standards at each site have yet to be determined. We believe disposal costs averaging about 11 million (1979) dollars per tailings pile are most likely. This estimate includes some costs that will probably not always be incurred, because some piles will not need to be moved to a new site or buried in an excavated pit. For some sites, the disposal cost will be partly offset by recovered land values or by uranium or other minerals recovered through reprocessing the tailings prior to disposal.

Exceptions

We believe that our proposed standards are the strictest that are justified for general application at all the inactive uranium processing sites covered by PL 95–604. However, providing greater protection may be reasonable at specific sites. Therefore, we urge the implementers to lower the residual risk as far below the required level as is reasonably achievable.

On the other hand, the standards could be unreasonably strict for certain circumstances. Because the scale of material-moving activity is so great, the possibility of serious harm to both workers and the general public from accidents associated with transporting an entire tailings pile to a new disposal site deserves particular consideration. Relocating a pile should be considered whenever it may not be practical to satisfy all the disposal standards at the original location. However, circumstances might be such that one would not expect the standards to be greatly exceeded within a thousand years, and that substantial human exposure to any resulting pollution would not necessarily occur. If all practical transport methods would probably cause serious harm to people from accidents, and if this and other risks associated with the transportation system are large enough, the near-term endangerment may outweight the additional long-term benefits of full rather than partial compliance with the standards. By carefully considering all these factors for each tailings pile where the issue arises, exceptions to the disposal standard could be justified because of the degree of unavoidable endangerment in attempting full compliance.

We do not consider the current remoteness of a pile from population centers sufficient by itself to justify relaxing the standards. Even small numbers of people nearby require protection, and the population of an area could increase considerably over the one thousand year period to which the standards apply. Furthermore, radon released from tailings piles travels over long distances.

In order to allow for reasonable implementation of PL 95–604, we are proposing criteria that may be used to determine whether particular circumstances justify exceptions to the disposal standards. In such exceptional cases, DOE, with the concurrence of NRC, may select and perform remedial actions that come as close to meeting the disposal standards as is reasonable. When doing so, DOE shall also inform EPA.

Note.—The costs and benefits of these standards are discussed in the Draft Environmental Impact Statement. However, our program to set remedial action standards for PL 95–604 does not require preparation of an economic analysis under Executive Order 12044. We expect the costs of the remedial action program in any calendar year to be less than the 100 million dollar criterion EPA has established (44 FR 30988–30998, May 29, 1979) for requiring an economic analysis.

Dated: December 31, 1980.

Douglas M. Costle,

Administrator.

Note.—Subparts B and C of the following were proposed earlier (45 FR 27370–27375, April 22, 1980) and are repeated here for the convenience of the reader.

The Administrator of the Environmental Protection Agency hereby proposes to add a Part 192, Subpart A, to Title 40 of the Code of Federal Regulations as follows:

PART 192—ENVIRONMENTAL PROTECTION STANDARDS FOR URANIUM MILL TAILINGS

Subpart A—Environmental Standards for the Disposal of Residual Radioactive Materials From Inactive Uranium Processing Sites

Subpart B—Environmental Standards for Cleanup of Open Lands and Buildings Contaminated With Residual Radioactive Materials From Inactive Uranium Processing Sites

Subpart C—Exceptions

Authority: Section 275 of the Atomic Energy Act of 1954, 42 U.S.C. 2022, as amended by the Uranium Mill Tailings Radiation Control Act of 1978, PL 95–604.

Subpart A—Environmental Standards for Disposal of Residual Radioactive Materials From Inactive Uranium Processing Sites

§ 192.01 Applicability.

This subpart applies to the disposal of residual radioactive material at any designated processing site or depository site as part of any remedial action conducted under Title I of the Uranium Mill Tailings Radiation Control Act of 1978 (PL 95–604), or following any use of subsurface minerals at such a site.

§ 192.02 Definitions.

(a) Unless otherwise indicated in this subpart, all terms shall have the same meaning as in Title I of the Uranium Mill

Tailings Radiation Control Act of 1978 and the Atomic Energy Act.

(b) *Remedial action* means any action performed under section 108 of the Uranium Mill Tailings Radiation Control Act of 1978.

(c) *Disposal* means any remedial action intended to assure the long-term, safe, and environmentally sound stabilization of residual radioactive materials.

(d) *Disposal site* means the region within the smallest practical boundaries around residual radioactive material following completion of disposal.

(e) *Depository site* means a disposal site selected under Section 104(b) or 105(b) of the Uranium Mill Tailings Radiation Control Act of 1978.

(f) *Aquifer* means a geologic formation, group of formations, or portion of a formation capable of yielding usable quantities of ground water to wells or springs.

(g) *Ground water* means water below the land surface in the zone of saturation.

(h) *Underground source of drinking water* means:

(1) An aquifer supplying drinking water for human consumption, or

(2) An aquifer in which the ground water contains less than 10,000 milligrams/liter total dissolved solids.

(i) *Curie* (Ci) means the amount of radioactive material which produces 37 billion nuclear transformations per second. One picocurie (pCi)=10–12 Ci.

(j) *Surface waters* means "waters of the United States, including the territorial seas" ("navigable waters") as defined in the Federal Register Volume 44, page 32901, June 7, 1979. (*Comment:* This definition is taken from the Regulations for the National Pollutant Discharge Elimination System, 40 CFR 122.3(t). In essence, it includes all U.S. surface waters which the public may traverse, enter, or draw food from.)

§ 192.03 Standards.

Disposal of residual radioactive materials shall be conducted in a way that provides a reasonable expectation that for at least one thousand years following disposal—

(a) The average annual release of radon-222 from a disposal site to the atmosphere by residual radioactive materials will not exceed 2 pCi/m^2-sec.*

(b) Substances released from residual radioactive materials after disposal will not cause

(1) The concentration of that substance in any underground source of drinking water to exceed the level specified in Table A, or

(2) An increase in the concentration of that substance in any underground source of drinking water, where the concentration of that substance prior to remedial action exceeds the level specified in Table A for causes other than residual radioactive materials.

This subsection shall apply to the dissolved portion of any substance listed in Table A at any distance greater than 1.0 kilometer from a disposal site that is part of an inactive processing site, or greater than 0.1 kilometer if the disposal site is a depository site.

(c) Substances released from the disposal isite after disposal will not cause the concentration of any harmful dissolved substance in any surface waters to increase above the level that would otherwise prevail.

§ 192.04 Effective date.

The standards of this Subpart shall be effective 60 days after final promulgation of this rule.

Subpart B—Environmental Standards for Cleanup of Open Lands and Buildings Contaminated With Residual Radioactive Materials From Inactive Uranium Processing Sites

§ 192.10 Applicability.

This subpart applies to open lands and buildings which are part of any processing site designated by the Secretary of Energy under Public Law 95–604, Section 102. Section 101 of Public Law 95–604, states that "processing site" means—

(a) Any site, including the mill, containing residual radioactive materials at which all or substantially all of the uranium was produced for sale to any Federal agency prior to January 1, 1971 under a contract with any Federal agency, except in the case of a site at or near Slick Rock, Colorado, unless—

(i) Such site was owned or controlled as of January 1, 1978, or is thereafter owned or controlled, by any Federal agency, or

(ii) A license (issued by the [Nuclear Regulatory] Commission or its predecessor agency under the Atomic Energy Act of 1954 or by a State as permitted under section 274 of such Act) for the production at such site of any uranium or thorium product derived from ores is in effect on January 1, 1978, or is issued or renewed after such date; and

(b) Any other real property or improvement thereon which—

(i) Is in the vicinity of such site, and

(ii) Is determined by the Secretary, in consultation with the Commission, to be contaminated with residual radioactive materials derived from such site.

Any ownership or control of an area by a Federal agency which is acquired pursuant to a cooperative agreement under this title shall not be treated as ownership or control by such agency for purposes of subparagraph (A)(i). A license for the production of any uranium product from residual radioactive materials shall not be treated as a license for production from ores within the meaning of subparagraph (A)(ii) if such production is in accordance with section 108(b).

§ 192.11 Definitions.

(a) Unless otherwise indicated in this subpart, all terms shall have the same meaning as defined in Title I of the Uranium Mill Tailings Radiation Control Act of 1978.

(b) *Remedial action* means any action performed under Section 108 of the Uranium Mill Tailings Radiation Control Act of 1978.

(c) *Open land* means any surface or subsurface land which is not a disposal site and is not covered by a building.

(d) *Working Level (WL)* means any combination of short-lived radon decay products in one liter of air that will result in the ultimate emission of alpha particles with a total energy of 130 billion electron volts.

(e) *Dose equivalent* means absorbed dose multiplied by appropriate factors account for differences in biological effectiveness due to the type and energ of the radiation and other factors. The unit of dose equivalent is the "rem."

(f) *Curie (Ci)* means the amount of radioactive material which produces 3 billion nuclear transformations per second. One picocurie (pCi) = 10^{-12}Ci

§ 192.12 Standards.

Remedial actions shall be conducted so as to provide reasonable assurance that—

(a) The average concentration of radium-226 attributable to residual radioactive material from any designated processing site in any 5 cm thickness of soils or other materials on open land within 1 foot of the surface, in any 15 cm thickness below 1 foot, shall not exceed 5 pCi/gm.

(b) The levels of radioactivity in any occupied or occupiable building shall not exceed either of the values specifi in Table B because of residual radioactive materials from any designated processing site.

*Note.—The radon emitted from a tailings site after disposal will come from the tailings and from materials covering them. Radon emissions from the covering materials should be estimated as part of developing a disposal plan for each site. These plans will be reviewed and concurred with by the Nuclear Regulatory Commission prior to disposal. After disposal, the radon emission standard is satisfied if the emission rate is less than or equal to 2 pCi/m^2-sec plus the emission rate expected from the disposal materials.

(c) The cumulative lifetime radiation dose equivalent to any organ of the body of a maximally exposed individual resulting from the presence of residual radioactive materials or byproduct materials shall not exceed the maximum dose equivalent which could occur from radium-226 and its decay products under paragraphs (a) and (b) of this section.

§ 192.13 Effective date.

The standards of this Subpart shall be effective 60 days after promulgation of this rule.

Subpart C—Exceptions

§ 192.20 Criteria for exceptions.

Exceptions to the standards may be justificable under any of the following circumstances:

(a) Public health or safety would be unavoidably endangered in attempting to meet one of more of the requirements of Subpart A or Subpart B.

(b) The goal of environmental protection would be better served by not satisfying cleanup requirements for open land, § 192.12(a) or the corresponding part of § 192.12(c). to justify an exception to these requirements there should be a clearly unfavorable imbalance between the environmental harm and the environmental and health benefits which would result from implementing the standard. The likelihood and extent of current and future human presence at the site may by considered in evaluating these benefits.

(c) The estimated costs of remedial actions to comply with the cleanup requirements for buildings, § 192.12(b) or the corresponding part of § 192.12(c), are unreasonably high relative to the benefits. Factors which may be considered in this judgment include the period of occupany, the radiation levels in the most frequently occupied areas, and the residual useful lifetime of the building. This criterion can only be used when the values in Table B are only slightly exceeded.

(d) There is no known remedial action to meet one or more of the requirements of Subpart A or Subpart B. Destruction and condemnation of buildings are not considered remedial actions for this purpose.

§ 192.21 Remedial actions for exceptional circumstances.

Section 108 of PL 95–604 requires the Secretary of Energy to select and perform remedial actions with the concurrence of the Nuclear Regulatory Commission and the full participation of any State which pays part of the cost, and in consultation, as appropriate, with affected Indian tribes and the Secretary of the Interior. Under exceptional circumstances satisfying one or more of the conditions § 192.20(a), (b), (c), and (d), the Department of Energy may select and perform remedial actions, according to the procedures of Section 108, which come as close to meeting the standard to which the exception applies as is reasonable under the exceptional circumstances. In doing so, the Department of Energy shall inform any private owners and occupants of affected properties and request their comments on the selected remedial actions. The Department of Energy shall provide any such comments to the parties involved in implementing Sec. 108 of Public Law 95–604. The Department of Energy shall also inform the Environmental Protection Agency of remedial actions for exceptional circumstances under Subpart C of this rule.

Table A

Milligrams/liter:	
Arsenic	0.05
Barium	1.0
Cadmium	0.01
Chromium	0.05
Lead	0.05
Mercury	0.002
Molybdenum	0.05
Nitrogen (in nitrate)	10.0
Selenium	0.01
Silver	0.05
pCi/liter:	
Combined radium-226 and radium-228	5.0
Gross alpha particle activity (including radium-226 but excluding radon and uranium)	15.0
Uranium	10.0

Table B

Average Annual Indoor Radon Decay Product Concentration (including background) (WL)	0.015
Indoor Gamma Radiation (above background) (milliroentgens/hour)	0.02

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Thursday
November 20, 1980

Part V

Environmental Protection Agency

Guideline for Federal Procurement of Cement and Concrete Containing Fly Ash

ENVIRONMENTAL PROTECTION AGENCY

40 CFR Part 249

[SWH-FRL 1567-8]

Guideline for Federal Procurement of Cement and Concrete Containing Fly Ash

AGENCY: Environmental Protection Agency.

ACTION: Proposed guideline.

SUMMARY: The Environmental Protection Agency (EPA) is today issuing proposed guidelines for the Federal procurement of cement and concrete containing fly ash implementing Section 6002(e) of the Resource Conservation and Recovery Act of 1976, as amended (RCRA). Section 6002 of RCRA requires procuring agencies using appropriated Federal funds to purchase items composed of the highest percentage of recovered materials practicable. Section 6002(e) instructs EPA to prepare guidelines to assist procuring agencies in complying with the requirements of Section 6002.

The preamble to the proposed guideline explains EPA's regulatory strategy for fulfilling its responsibilities under Section 6002 of RCRA.

DATES: Comments are due on January 15, 1981. A public hearing will be held on January 8, 1981 from 9:00 a.m. to 4:00 p.m.

ADDRESSEE: Comments should be addressed to RCRA Docket Clerk, Office of Solid Waste (WH-562), U.S. Environmental Protection Agency, Washington, D.C. 20460. Comments should identify the docket number, which is "Section 6002."

The public hearing will be held at EPA Waterside Mall, Room 3906, 401 M Street, SW., Washington, D.C.

FOR FURTHER INFORMATION CONTACT: John Heffelfinger, Hazardous and Industrial Waste Division, Office of Solid Waste (WH-565), U.S. Environmental Protection Agency, Washington, D.C. 20460; (202) 755-9206.

SUPPLEMENTARY INFORMATION: *Public Hearing:* A public hearing will be held on January 8, 1981 at EPA Waterside Mall, Room 3906 from 9:00 a.m. to 4:00 p.m. Registration will begin at 8:30 a.m. Anyone wishing to make an oral statement at the hearing should notify, in writing: Ms. Geraldine Wyer, Public Participation Office, Office of Solid Waste (WH-562), U.S. Environmental Protection Agency, Washington, D.C. 20460. Oral and written comments may be submitted at the public hearing. Persons who wish to make oral presentations are encouraged to have written copies of their complete comments for inclusion in the official record.

Public Docket: The public docket for this guideline is located in: Room 2711B, U.S. Environmental Protection Agency, 401 M Street, SW., Washington, D.C. 20460, and is available for viewing 9:00 a.m. to 4:00 p.m. Monday through Friday excluding holidays.

Introduction

Purpose and Scope

The Environmental Protection Agency is today proposing the first of a series of guidelines designed to encourage the use of products containing recovered materials. Section 6002 of the Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act of 1976, as amended ("RCRA" or "Act"), 42 U.S.C. 6962, requires Federal, State, and local procuring agencies using appropriated Federal funds to purchase items composed of the highest percentage of recovered materials practicable. EPA is required to prepare guidelines to assist procuring agencies in complying with the requirements of Section 6002.

This preamble explains EPA's regulatory strategy for fulfilling its responsibilities under Section 6002 of RCRA. Comments are requested on this regulatory strategy as well as on the specific guideline being proposed.

RCRA

The objectives of the Resource Conservation and Recovery Act are the protection of human health and the environment and conservation of valuable material and energy resources. The Act sets forth a national program to achieve these objectives by improving solid waste management practices. The provisions of the Act include (1) requirements for control of the generation, transportation, treatment, storage, and disposal of hazardous wastes, (2) establishment of environmentally sound disposal practices for all wastes, and (3) investigation and creation of incentives for resource recovery and conservation activities. These activities are to be carried out through a cooperative effort among Federal, State, and local governments, as well as private industry.

Requirements of Section 6002

Section 6002 of the Act, titled Federal Procurement, directs all procuring agencies which use appropriated Federal funds to procure items containing the highest percentage of recovered materials practicable, given that reasonable levels of competition, cost, availability, and technical performance are maintained.

Procuring agencies are also required to review and revise specifications for products in order to eliminate any discrimination against the use of recovered materials. They are to remove specifications requiring that items be manufactured from virgin materials, and remove prohibitions against the use of recovered materials.

Section 6002 gives the Environmental Protection Agency responsibility for promulgating guidelines to assist procuring agencies in carrying out these requirements and (in conjunction with the Office of Federal Procurement Policy in the Executive Office of the President) for implementing the policy and program at all levels of government.

Section 6002 is aimed at achieving the materials conservation goal. Its clear objective is to use the economic incentive of Federal procurement to increase the recovery of solid waste materials. Federal procurement of products made from recycled materials can demonstrate their technical and economic viability as they are used by Federal, State and local agencies.

The specific provisions of Section 6002 are:

"(a) * * * a procuring agency shall comply with the requirements set forth in this section * * * with respect to any purchase or acquisition of a procurement item where the purchase or acquisition of a procurement item where the purchase price of the item exceeds $10,000 or where the quantity of such items or of functionally equivalent items purchased or acquired in the course of the preceding fiscal year was $10,000 or more."

"(c)(1) * * * each procuring agency shall procure items composed of the highest percentage of recovered materials practicable consistent with maintaining a satisfactory level of competition. The decision not to procure such items shall be based on a determination that such procurement items—

"(A) Are not reasonably available within a reasonable period of time;

"(B) Fail to meet the performance standards set forth in the applicable specifications or fail to meet the reasonable performance standards of the procuring agencies; or

"(C) Are only available at an unreasonable price."

"(c)(3) After the date specified in any applicable guidelines prepared pursuant to subsection (e) of this section, contracting officers shall require that vendors certify the percentage of the total material utilized for the performance of the contract which is recovered materials."

"(d) Specifications.—(1) All Federal agencies that have the responsibility for drafting or reviewing specifications for procurement item procured by Federal agencies shall, in reviewing those specifications, ascertain whether such specifications violate the prohibitions contained in subparagraphs (A) through (C) of paragraph (2). Such review shall be undertaken not later than eighteen months after the date of enactment of this section.

"(2) In drafting or revising such specifications, after the date of enactment of this section—

"(A) Any exclusion of recovered materials shall be eliminated;

"(B) Such specification shall not require the item to be manufactured from virgin materials; and

"(C) Such specifications shall require reclaimed materials to the maximum extent possible without jeopardizing the intended end use of the item."

"(e) Guidelines.—The Administrator, after consultation with the Administrator of General Services, the Secretary of Commerce (acting through the Bureau of Standards), and the Public Printer, shall prepare, and from time to time revise, guidelines for the use of procuring agencies in complying with the requirements of this section. Such guidelines shall set forth recommended practices with respect to the procurement of recovered materials and items containing such materials and with respect to certification by vendors of the percentage of recovered materials used, and shall provide information as to the availability, sources of supply, and potential uses of such materials and items."

"(g) The Office of Procurement Policy in the Executive Office of the President, in cooperation with the Administrator, shall implement the policy expressed in this section. It shall be the responsibility of the Office of Procurement Policy to coordinate this policy with other policies for Federal procurement, in such a way as to maximize the use of recovered resources, and to annually report to the Congress on actions taken by Federal agencies and the progress made in the implementation of such policy."

Background

The use of Federal procurement as a tool in accomplishing social, environmental, and economic goals is not new. Federal laws provide procurement preferences for:

—Small business concerns;
—Labor surplus area concerns;
—Low-noise-emission products;
—American-made products.

Other laws prohibit Federal purchases of products from firms which are in violation of pollution regulations.

In the case of the Buy American Act, regulatory provisions allow procuring agencies to pay a six, twelve, or fifty percent premium for domestically-manufactured products, by adding from six to fifty percent to the bid price of non-domestically produced items. Bids are then evaluated as if these were the actual bid quotations received and the award is made to the lowest responsible bidder. In the case of low-noise-emission products, up to a twenty-five percent premium may be paid for products which are certified as such.

The use of Federal leverage specifically to stimulate demand for recycled materials has been supported by several authoritative sources. Section 205 of the Solid Waste Disposal Act, as amended, mandated the Administrator to:

"* * * carry out an investigation and study to determine * * * the use of Federal procurement to develop market demand for recovered resources."

Chapter 4D.6 and 4D.7 of the final report of the National Commission on Materials Policy recommended that:

"* * * the Federal Government exercise leadership by using its purchasing power to provide a market for products made from recycled materials.

"* * * the Federal Government help reduce the flow of solid waste by establishing, within Federal purchasing departments, performance standards rather than composition standards that discriminate against secondary materials."

In 1971, the President's Environmental Message to Congress directed the General Services Administration to purchase paper which contained recycled material. The program instituted by GSA led to revisions in at least 86 purchase specifications, including those for building materials, office supplies, packaging, and tissue products. GSA now requires certain of these products to include percentages of recovered materials ranging from three up to one hundred.

On January 15, 1976, EPA promulgated Guidelines for Procurement of Products that Contain Recycled Material (40 CFR, Part 247) under the authority of the Resource Recovery Act of 1970 (Pub. L. 91–512). Those guidelines were advisory and were intended to increase the use of recycled materials in products purchased by Federal agencies. The general recommendations contained in those guidelines were reflected in the statutory language of Section 6002 of the Resource Conservation and Recovery Act of 1976.

Explanation of Current Regulatory Approach

General vs. Specific Guidelines

Soon after EPA undertook the effort to prepare procurement guidelines, it became clear that guidelines could not be developed for all 50,000 Federal product specifications and standards. It is impossible to review all 50,000 Federal product specifications and make decisions on that percentage of recoverable materials is technically and economically feasible, available in a reasonable amount of time, and produced by enough companies to guarantee that competition is maintained.

Two major alternatives for fulfilling the RCRA mandate were considered. They were:

(1) To issue a general guideline recommending procedures to be used by procuring agencies in amending product specifications and revising procurement practices so as to encourage the use of products containing recovered materials. This was the purpose of the January 1976 EPA guidelines for procurement of recycled products; or

(2) To issue specific guidelines on selected products containing detailed recommendations as to revisions in product specifications and procurement practices and information on availability, sources of supply and potential uses of the product.

The first alternative was rejected because it did not completely satisfy the intent of the Act. Section 6002 specifically states that EPA's guidelines are to provide information on availability, sources of supply, and potential uses of recovered material products. Procuring agencies in most cases do not have the resources available to obtain this information. Therefore, EPA chose the second alternative (i.e., selection of product areas where increased use of recoverd materials would be practical). EPA will provide recommendations for revisions in procurement practices and information on availability and potential uses for specific products made from recovered materials.

RCRA Amendments

The product-specific approach which EPA has selected reflects the proposed amendments to RCRA which have been passed by both the Senate (S. 1156) and the House of Representatives (H.R. 3994). The primary impact of these amendments would be to key all of the purchasing requirements of Section 6002(c) to the preparation by EPA of guidelines for particular products. Toward this end, EPA is directed to "designate those items which are or can be produced with recovered materials and whose procurement by procuring agencies will carry out the objectives of (Section 6002)."

In anticipation of passage by Congress of the proposed Section 6002 amendments, EPA has attempted to draft this guideline so that it conforms with the applicable provisions of both the existing Section 6002 and the Section 6002 amendments.

Criteria For Selection of Product Areas

Criteria were developed to aid in the selection of product areas for which guidelines would be prepared. These criteria are:

(1) The waste material must constitute a significant solid waste management problem due either to volume, degree of hazard or difficulties in disposal;

(2) Economic methods of separation and recovery must exist;

(3) The material must have technically proven uses; and

(4) Federal purchasing power for the final product must be substantial.

Comments are specifically requested on the Agency's choice of criteria for product selection, as these criteria are proposed to be used in the selection of products for inclusion under future guidelines.

Product Areas Currently Under Study

With these criteria in mind, EPA has initially chosen four major product categories for the issuance of guidelines under Section 6002. These categories are fly ash in cement and concrete, composted sewage sludge in soil amendments, recycled paper products, and highway construction products containing recovered materials. EPA expects additional candidate products to surface through its industry solid waste studies program. As guidelines are completed in these areas, additional product areas will be selected for issuance of guidleines.

Comments are specifically requested on the Agency's choice of product areas for issuance of guidelines. The Agency also requests suggestions for additional product areas for consideration, accompanied by documentation as to how any new products satisfy the criteria.

Rationale for Choosing to Issue Guideline Pertaining to Fly Ash

Fly ash used in cement and concrete was chosen as a product area were Federal purchasing power could significantly increase the use of a recovered material. The following discussion demonstrates that fly ash meets the product selection criteria.

(1) *Significant Solid Waste Problem.* Fly ash is the term used to describe an ash component of coal which results from the combustion of coal. The vast majority of fly ash is produced in electric power generating plants, where powdered coal is burned to produce steam to drive the turbines. Fly ash, which is a finely divided imcombustible mineral residue, is conveyed out of the boiler along with the stack gases. It is then collected from the gases by various means, including electrostatic precipitators, mechanical precipitators, cyclone separators, bag houses and scrubbers. It is stored in silos, awaiting reuse or disposal, or it may be conveyed directly to a disposal area. Fly ash typically represents about 70 percent of the ash generated by coal combustion, with coarser and heavier bottom ash accounting for the remaining 30 percent.

During 1978, 48.3 million tons of fly ash were generated, with over 82 percent disposed of as waste. The quantities of fly ash requiring disposal will increase dramatically during the 1980's with the construction of additional coal burning power plants. Estimates are for fly ash generation to be 70–80 million tons annually by 1985.

(2) *Feasible Methods of Recovery.* Economically feasible methods exist for recovery of fly ash from the waste stream. Electrostatic precipitators or mechanical collection devices separate fly ash from boiler stack gases. In fact, more than two-thirds of the coal-fired generating stations have collection and loading facilities for fly ash. However, the majority of fly ash currently is combined with bottom ash, boiler slag, and/or scrubber sludge for disposal, making future recovery for cement and concrete use impossible.

(3) *Technically Proven Uses.* Cement is a powder-like manufactured mineral product, usually gray in color. Cement is mixed with water and sand, gravel, crushed stone, or other aggregates to form the hard substance known as concrete. Cement is not used by itself for construction but is a component of concrete.

Cement is produced by first grinding a carefully proportioned mixture of raw materials such as limestone, silica, sand, clays, and iron ore. The mixture is heated in huge rotary kilns at temperatures approximating 1500° C (2700° F), where chemical reactions take place. The resulting marblesize pellets, or clinker, are ground with a small amount of gypsum (to control setting and hardening) to produce an extremely find powder, known as "portland" cement. Portland cement is a generic term used to describe a particular type of inorganic hydraulic cement. A hydraulic cement is a cement which will combine with water and harden.

Although not cement itself, fly ash has the property of cementation when combined with lime and water, and this can complement the cementing action of portland cement. Fly ash combines with the water-soluble lime generated during the reaction of portland cement with water, and forms insoluble cementitious compounds. This cementitious property gives fly ash two primary uses: As an ingredient in blended cements, and as a component of portland cement concrete. When used to produce blended cement, fly ash is either interground with the portland cement clinker, or blended with the finely ground portland cement powder (or both). When used directly in concrete, fly ash is added to the standard concrete ingredients at the concrete mixing site. Fly ash can be used either as a partial cement replacement in concrete, or as an added ingredient to obtain certain desired concrete characteristics.

a. *Blended Cement.* Several U.S. cement manufacturers produce a blended cement meeting the standards prescribed by the American Society for Testing and Materials (ASTM) for the use of fly ash in cement. Blended cement containing fly ash is included in ASTM specification C595 and is designated as "Type IP" or "Type I(PM)." Table 1 indicates the extent to which Type IP or Type I(PM) cement can be used as a substitute for ASTM cement Types I through V in general concrete construction.

Table 1

ASTM cement type	Purpose	Substitute fly ash
I	General purpose	Yes.
II	Moderate sulfate resistance and heat of hydration.	Yes.
III	High early strength	No.
IV	Low heat of hydration	Yes.
V	High sulfate resistance	Yes.

b. *Concrete Admixture.* Fly ash can also be used directly as an admixture in concrete, as a partial replacement for portland cement. ASTM specification C311 contains requirements for the sampling and testing of fly ash when used in this manner. ASTM C618 is the standard specification for the use of fly ash as an admixture in concrete. In addition, the General Services Administration maintains Federal Specification SS–C–1960, which references ASTM C618, with minor diferences for sulfur trioxide content, loss on ignition, and the pozzolanic activity index.

On a national level, the U.S. Army Corps of Engineers has used fly ash in concrete in various projects, most notably dam construction, for many years. Some State Departments of Transportation have approved its use. For example, the Georgia Department of Transportation (DOT) revised its specifications in 1975 to allow fly ash to be used as a partial cement replacement. Since then, Georgia's DOT has placed over three million cubic yards of fly ash concrete pavement and road shoulders, and is now considering review of the specification to allow for a greater fly ash replacement rate.

Many ready mixed concrete producers and concrete product manufactuers have used fly ash for years, particularly in non-specification jobs where they are responsible for the performance of the product, but are able to choose the material content which will best suit their needs both technically and economically.

c. *Enhanced Performance.* The use of fly ash in cement and concrete may enhance the performance characteristics of the final products.* These advantages can be summarized as follows:

1. *Greater Ultimate Strength.* Proper nix design will achieve 28-day strength equal to or better than a typical Type I cement. Fifty-six day strength will be superior in almost all cases. In Chicago, he Sears Tower, John Hancock Center, and Standard Oil Building all ncorporate fly ash. Use of fly ash was ound to be the most practical and economical method of obtaining high strength mixes.

2. *Improved Workability.* Specification fly ash used in properly proportioned concrete mixes improves he pumpability, handling, placing, and inishing of fresh concrete, in part due to he glassy, spherical shape of fly ash particles which add to the "plasticity" of he mix.

3. *Reduced Water Requirement.* Due o improved workability, usually less water needs to be added to the mix, esulting in less drying shrinkage and ess cracking.

4. *Lower Heat of Hydration.* Generally, less heat is generated during he chemical reactions between the ement and water, resulting in less hermal cracking; especially important n mass concrete applications such as dams, large beams, retaining walls, and foundations.

5. *Increased Sulfate Resistance.* A proper mix with certain classes of fly ash will reduce the chemical attacks in concrete from sulfates contained in adjacent soil and groundwater. These reactions cause cracking and eventual disintegration of the concrete. Fly ash forms stable cementitious compounds with certain cement constituents, thus reducing the ability of sulfates to combine with these same cement constituents.

6. *Reduced Alkali-Aggregate Reactions.* Certain aggregates react with the alkalis generated during cement hydration, resulting in disruptive expansion and cracking of concrete. Certain classes of fly ash react with these alkalis to form stable compounds, thus preventing or severely reducing the reaction with aggregates and the accompanying detrimental effects.

d. *Disadvantages.* Several disadvantages which are associated with the use of fly ash can be overcome through proper use.

1. *Variable Physical and Chemical Composition.* Fly ash can be highly variable in its physical and chemical composition. This variability can be due to several factors, such as coal source, combustion process, and collection method. This problem can be overcome through adequate testing and quality control of the ash. ASTM specifications C595, C311, and C618 should be used as minimum standards for acceptance of fly ash. However, these material standards by themselves will not guarantee satisfactory performance of a concrete mix. Therefore, EPA emphasizes the need for quality assurance procedures on the part of the concrete contractor. Some users of ash (e.g., Federal and State governments) require that those who wish to incorporate fly ash in concrete must obtain ash from approved sources.

2. *Unfamiliar Users.* Due to lack of widely publicized and sometimes inadequate data on mix designs (as compared to general purpose concrete), fly ash concrete may be improperly prepared by an unfamiliar user. Mix designs do exist to produce fly ash concrete, and in most cases fly ash brokers/companies will provide manufacturing assistance and engineering design aid. The "References" section of this guideline refers to information on fly ash and its use in cement and concrete. Potential users should familiarize themselves with the information in those publications.

3. *Special Storage and Transportation Equipment.* Due to its extreme fineness, fly ash requires the use of storage and conveying equipment with tight fittings. Equipment meeting these requirements is readily available.

4. *Extended Curing Time.* Mix proportions have been developed which will achieve equal or superior strength to general purpose concrete at all ages, particularly if 10%–30% fly ash is added to a concrete mix, or if a blended cement with up to 10% fly ash content is used. However, when used as a cement replacement, superior strength is usually not achieved until the age of 28 days.

5. *Increased Demand for Air Entraining Agent.* Fly ash used in blended cements and concrete will often cause an increased demand for air entraining agent. With proper testing and quality control, the need for entrained air can be satisfied. The cost of the additional air entraining agent and quality control is often balanced by the cost savings associated with fly ash use.

(4) *Federal Purchasing Power.* Almost one-half of total U.S. cement consumption is in public construction projects (public buildings, public works, transportation). Since Federal funds account for nearly two-thirds of the funding for public construction nationally, approximately 23 million tons of cement is purchased annually either directly or indirectly with Federal funds. These 23 million tons mark the theoretical universe to which this guideline applies.

The actual figure may be lower, however, as some of these cement applications may not be technically appropriate for the use of fly ash. In addition, some of these Federally-funded projects already incorporate fly ash. On the other hand, with the anticipated "ripple effect" of private purchases being influenced by these public purchases, the impact could be substantially increased.

Guideline for Federal Procurement of Cement and Concrete Containing Fly Ash

Purpose

The purpose of this guideline is to increase the use of fly ash in cement and concrete purchased with Federal funds. Fly ash is a by-product of coal combustion. Its increased use in cement and concrete will help reduce this source of solid waste. At the same time this will conserve both significant amounts of energy and natural resources used in making cement. Cost savings can be achieved while providing a product that can be equivalent or even superior to cement and concrete made using only virgin materials.

*The properties of cement and concrete which ntain fly ash have been examined and ocumented. A report by the National Bureau of andards entitled "The Utilization of Industrial By-oducts in Blended Cements" summarizes these operties.

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This guideline will increase the demand for recovered fly ash in Federally-funded construction. This increased demand should improve the marketability of fly ash and promote wider acceptance of it as a cement substitute and concrete additive. This together with the cost savings of fly ash in local markets may result in its more widespread use in non-Federally funded construction as well.

Contents of the Guideline

This guideline designates fly ash used in cement and concrete as a product area for which procuring agencies must exercise affirmative procurement under Section 6002 of RCRA and presents recommendations for carrying out the requirements of Section 6002 with respect to fly ash used in cement and concrete. RCRA defines procuring agencies to include not only Federal agencies, but also state and local agencies, grantees, and contractors which are using Federal funds to purchase cement and concrete.

Section 6002 of the Act sets forth certain requirements for procuring agencies. These requirements include (1) eliminating from specifications any discrimination against the use of recovered materials; (2) purchasing products which contain recovered material if reasonable levels of technical performance, cost, availability, and competition can be achieved; and (3) obtaining certification from suppliers of the actual percentage of recovered materials used in the performance of the contract. (The proposed amendments to RCRA change this last requirement so that suppliers would certify that they have met any minimum contractual requirements for including recovered materials.)

To assist procuring agencies achieve compliance with these requirements, this guideline recommends that procuring agencies who purchase cement or concrete adopt a dual bid approach and solicit bids for both portland cement alone and portland cement with fly ash (either as a blended cement or as an admixture) except where the use of fly ash would be technically inappropriate. This guideline further recommends that a procuring agency which knows cement or concrete containing fly ash is reasonably available, technically appropriate, and economically competitive with portland cement or concrete should only solicit bids for cement or concrete containing fly ash. In addition, this guideline recommends that procuring agencies revise their guide specifications and design guidelines to ensure that fly ash use is allowed, except where technically inappropriate. It suggests certification procedures which utilize the existing review and approval mechanisms already imposed by procuring agencies.

Phased-in implementation, with specification changes to be made in the first year after publication of this guideline and purchases to begin in the second year, is recommended.

Discussion of Proposed Guideline

This section of the preamble summarizes and explains the proposed guideline and its integration with the requirements of Section 6002 of the Act. The recommendations of this proposed guideline, with regard to specifications, purchasing, and certifications are nonmandatory and adherence to them is voluntary. These recommendations represent the best information available to EPA and provide suggested procedures for achieving compliance with Section 6002. EPA specifically requests comments on certain issues, although comments are invited on all issues contained in the proposed guideline, this preamble and the support documents.

Scope

The scope of this guideline is limited to the use of fly ash in cement and concrete.

Fly ash can also be used in many other construction applications, such as road base material, structural fill and embankment, and as lightweight aggregate. However, the technical and economic issues related to these uses of fly ash are sufficiently different to warrant separate consideration by procuring agencies. The Agency intends to prepare guidelines on a product-by-product basis. Guidelines on the use of fly ash in road bases and structural fill and embankment are currently under consideration.

The Agency considered expanding this guideline to include the use of granulated iron blast furnace slag in cement and concrete. However, granulated slag of the quality and quantity required is not currently available. In addition, iron blast furnace slag is already reused at a very high rate, as aggregate and as fill material. The Agency may amend this guideline or issue a separate guideline in the future as performance, cost, and availability of granulated blast furnace slag is established.

Similarly, silica fume, the by-product dust resulting from the manufacture of silicon metal and collected in the air pollution control devices, has been studied for its use in cement and concrete. The U.S. Army Corps of Engineers has developed results which indicate that silica fume can be extremely beneficial in increasing the resistance of concrete to sulfate attack, while generally maintaining early strength similar to that of portland cement concrete not containing the dust. However, additional technical information and standards need to be developed before this material is used on a national scale. Thus, a specific procurement guideline is not currently appropriate for silica fume.

In the meantime, agencies, should apply the general provisions of this guideline in those cases where suitable granulated slag, silica fume, and other recovered materials become available. This guideline should not be construed as preventing the procurement of other recovered materials suitable for use in cement and concrete.

Comment is requested on the Agency's decision to limit the scope of this guideline to the use of fly ash in cement and concrete.

Applicability

The requirements of Section 6002 apply to "procuring agencies." The term "procuring agency" is defined by the Act as "any Federal agency, or any State agency or agency of a political subdivision of a State which is using appropriated Federal funds for such procurement, or any person contracting with any such agency with respect to work performed under such contract."

This guideline recommends that any purchases of cement or concrete made with Federal funds, either directly or indirectly, allow for fly ash to be bid as an alternate material, unless it can be shown that the use of fly ash is technically inappropriate for a particular construction application. This guideline further recommends that a procuring agency which knows that cement or concrete containing fly ash is reasonably available and cost competitive with portland cement or concrete should only solicit bids for cement or concrete containing fly ash, assuming the agency knows that a satisfactory level of competition will also be maintained.

With regard to direct purchases, there are several situations to which the Agency believes this guideline should apply. Although the language on applicability in Section 6002 leaves room for interpretation, the Agency believes the recommendations here best describe the intent and practical application of Section 6002.

The first is the case where a Federal agency purchases cement, either in bag or bulk form. The agency itself may use this cement or it may supply the cement to other persons or the cement may be used by a person performing construction services for the Agency. For example, if the Department of Defense, Navy, were to purchase cement for use on a construction job, or if a general contractor or subcontractor were to purchase cement for use on that job, all would be subject to the provisions of this guideline.

A second case is where ready-mixed concrete is purchased directly by a Federal agency. The same scenarios applied to direct purchases of cement apply here. If a Federal agency purchases ready-mixed concrete for its own use or, more likely, if a person under contract to or in support of a Federal agency purchases concrete, then the provisions of this guideline apply.

Indirect Federal purchases of cement and concrete are also subject to this guideline. This is where the coverage of the term "procuring agency" becomes critical. Foremost among indirect consumers of cement and concrete are the Department of Transportation (including the Federal Highway Administration, Federal Aviation Administration, Urban Mass Transit Administration); the Department of Health and Human Services; the Department of Housing and Urban Development; and the EPA itself (wastewater treatment works construction grants program). All these agencies are involved in the Federal funding of construction programs for or through state and local governmental authorities. Any purchase of at least $10,000 worth of cement and concrete by these groups—or by contractors, subcontractors, grantees or other persons using Federal funds resulting from grants, loans, funds or similar forms of disbursements of monies—is subject to the provisions of this guideline.

EPA recognizes that these cases of indirect Federal funding may present the most difficulty for implementation. For instance, while the Federal Procurement Regulations and Armed Services Procurement Regulations control all Federal agencies in the case of direct procurement, each individual agency establishes its own grant regulations. In addition, agency reviews appear to exert little influence over the composition of materials used in construction activities. An agency's primary interest is that the project performs as intended. EPA specifically requests comments on the guideline's applicability and practicality for these indirectly funded programs.

Another important issue here is the applicability of the $10,000 rule. The guideline would apply where a procuring agency directly purchases more than $10,000 worth of cement or concrete during the course of any fiscal year. The rule is complicated if a procuring agency purchases concrete "services," which would not only involve the supply of the product but also placement, finishing, etc. Even more complex is the case where a contractor is assigned all construction activities for a particular agency project, including subcontracting authority for concrete work. In such cases the actual cost of the cement or concrete may not be readily determinable. EPA is proposing that the $10,000 limitation include the cost of services related to purchase of the product as well as the cost of the product itself, at least in those cases where the separate cost of each cannot be practically determined. Comments are solicited on this issue.

This guideline should not apply to construction activities being performed which are only tangentially related to Federal funding. For example, a contractor may perform laboratory experiments and bench-scale tests for the Government under a contract. In order to carry out his responsibilities he may need to expand his existing physical facility or construct a new one. The cement and concrete used in that structure would not be subject to the requirements of Section 6002 or this guideline, even though some of the funds received from Federal contract payments might be used to finance the construction. We request comments on this issue.

Definitions

Of the definitions which are contained in this proposed guideline, most are self-explanatory and non-controversial and therefore need not be addressed in this preamble. In addition to the definition of "procuring agency" discussed above, the terms "recovered material" and "solid waste" deserve discussion.

The requirements of Section 6002 apply to products containing recovered materials. The definition of "recovered material" contained in this guideline is the same as that in RCRA. The term is defined as "material which has been collected or recovered from solid waste." Confusion exists regarding exactly what materials qualify as recovered materials. For example, can a material which has never been "thrown away" or "discarded," as is often the case with fly ash used in cement and concrete, be considered a recovered material? The answer to this lies in determining whether the material in question is in fact a solid waste, as discussed below.

The definition of "solid waste" used in this proposed guideline is that used in the Hazardous Waste Management System regulations, promulgated by EPA on May 19, 1980. The statutory definition of "solid waste" in RCRA makes unclear EPA's authority to regulate the use, reuse, recycling, or reclamation of wastes. Many commenters on the hazardous waste regulations argued that EPA could not regulate materials as solid wastes which were recovered and reused, because such materials were not "discarded," "thrown away," or "abandoned," (terms used in the preamble to the proposed regulations). Among other things such a position would preclude EPA's ability to write guidelines for Federal procurement of recycled products (including fly ash) under Section 6002 of RCRA unless the recycled material had at one time been completely abandoned and recovered from a solid waste stream.

EPA disagreed with these commenters' position in publishing the final regulations for hazardous waste management. Solid wastes do not cease to be solid wastes simply because they are being used, reused, recycled, or reclaimed. Rather use, reuse, recycling, resource recovery, and reclamation are ways of managing solid wastes which, if properly conducted, can avoid environmental hazards, protect scarce land supply, and reduce the nation's reliance on foreign energy and materials. Thus, according the the definition of "solid waste" now used in this proposed guideline, fly ash is clearly a solid waste, and fly ash used in cement and concrete is clearly a recovered material under Section 6002 of RCRA.

Specifications

Section 6002 of the Act requires revision of all specifications for cement and concrete for which Federal agencies have drafting and review responsibility so that they no longer exclude the use of fly ash—and so that they incorporate the use of fly ash to the maximum extent.

To assist agencies in achieving compliance with this requirement, the guideline makes several recommendations on specifications. It suggests alternatives to an otherwise strict interpretation of Section 6002. There are three major categories of specifications for which recommendations are made:

- Guide specifications—typically, model standards or specifications issued by a procuring agency, which are suggested or required for use in the design of all of the construction projects of an agency (these are often referred to as design standards or design guidelines).

- Contract specifications—a precise set of specifications prepared for a particular construction project, which contains such items as design, performance, and material requirements for that project.
- Material specification—a specification that stipulates the use of certain materials to meet the necessary performance requirements.

Guide Specifications

Procuring agencies will need to review and revise guide specifications to comply with the recommendations of this guideline. In doing this, the agencies will need to eliminate any discrimination, either direct or indirect, against the use of fly ash in cement and concrete. In addition they must ensure that guide specifications require that the use of fly ash be considered and incorporated, where appropriate, into contract specifications for individual construction projects. EPA recommends a period of six months after the date of final promulgation of the guideline to complete review and revision of guide specifications.

Contract Specifications

Ultimately this guideline will have its greatest effect on contract specifications which are prepared for each individual construction project. The guideline recommends that agencies make sure that specifications for individual construction contracts allow for the use of fly ash as an alternate material, unless it can be shown that this would be technically inappropriate. It also recommends that the agency document decisions to exclude fly ash from contract specifications, in order to respond to possible protests or inquiries. Placing the burden upon the procuring agency to assure that fly ash is allowed in contract specifications is particularly important where the design function is outside this agency, where construction projects are being performed as a result of grants, loans, funds, etc. Thus it is critical that the technical officer or engineer on a contract work closely with the contracting or grant officer to assure that fly ash is appropriately considered.

EPA recommends that procuring agencies take no more than twelve months from the date of final promulgation of the guideline to assure that contract specifications reflect the requirements of Section 6002. EPA requests comments on any issue related to revision of guide specifications and contract specification.

Material Specifications—Fly Ash Content

Both Federal specifications and national voluntary consensus standards exist for the use of fly ash in blended cement and in concrete. Rather than actually revise existing material specifications for portland cement, for instance, procuring agencies are expected to make maximum use of these existing material specifications.

This guideline suggests no minimum, maximum, or absolute level of fly ash content in blended cement or concrete which is subject to this guideline. Flexibility is necessary because of variation in fly ashes and cements, strength requirements, relative costs, and even local and regional construction practices and climatic conditions.

The provisions of ASTM specification C595 for blended hydraulic cement require that type IP cement contain 15%–40% fly ash and that Type I (PM) cement contain 0–15% fly ash by weight, thus allowing fly ash content to be specified in a range from zero to forty percent. A typical blending rate in the industry appears to be around 20%. However, the actual proportion to use needs to be determined on a job-by-job basis in accordance with established mix design procedures and performance needs.

When used directly in the manufacture of concrete, industry practice indicates that more fly ash should be used than the amount of cement replaced. This ratio should be at least 1.25–1.50 fly ash to 1.00 unit of cement. Typical replacement rates are around the 15% level, but the actual percentage needs to be determined on a job-by-job basis.

Allowing the use of low levels of fly ash in cement and concrete may encourage additional companies to experiment with the product and gain expertise. This could ultimately increase the number of companies using fly ash, and the amount of fly ash they use.

Information contained in the "References" can be used as guidance in determining proper fly ash content.

Performance Standards

It is often claimed that designs of construction projects are conservative and, as a safeguard, intentionally increase the strength requirements beyond what the design criteria actually requires. Setting concrete strengths which are higher than actually needed during the several days following concrete placement (i.e., "high early strength") can deter the use of fly ash. Although fly ash will generally enable a concrete to achieve a higher ultimate strength (e.g. at 28, 56, and 90 days), very high early strength can be achieved only by adding fly ash to the mixture without reducing the cement content. In this situation, the ecomomic and energy conservation advantages of using fly ash are sharply diminished.

EPA recommends revising certain performance standards where appropriate, primarily to extend the period for strength evaluation. EPA requests comment on this issue. Any suggested revision to the proposal should be supported by appropriate data and/or documentation.

Purchasing

EPA is designating fly ash used in cement and concrete as a product area for which procuring agencies must exercise affirmative procurement actions under Section 6002 of RCRA. As discussed in this Preamble under the section entitled "RCRA Amendments," when EPA "designates" a product area through the issuance of guidelines, RCRA requires that procuring agencies take positive steps to purchase that product. This section of the guideline contains recommendations for satisfying the affirmative procurement requirement.

Bidding Approach

EPA recommends that procuring agencies utilize a dual bid approach for cement and concrete purchases. All bid solicitations for cement and concrete should solicit bids for both portland cement or concrete and cement or concrete containing fly ash, where technically appropriate. Award would be made to the lowest priced responsible offeror.

EPA further recommends that where the application is technically appropriate and where a procuring agency is satisfied that cement or concrete containing fly ash is reasonably available and its bid price will be competitive with that of portland cement or concrete, only bids for cement or concrete containing fly ash should be solicited. Award would still be made to the lowest priced responsible offeror.

Allowing vs. Requiring Sole Use of Fly Ash

EPA considered recommending that procuring agencies require the use of cement or concrete containing fly ash in all cases where it is technically appropriate, even where procuring agencies did not know it to be reasonably available or cost competitive. EPA did not choose to take this step for several reasons:

(1) Assuming satisfactory technical performance, RCRA requires that a recovered material product be

purchased only if the product is available in a reasonable period of time, the product can be obtained at a reasonable price, and the purchase is consistent with maintaining a satisfactory level of competition. If cement or concrete containing fly ash were always required where technically appropriate, the burden of determining reasonably levels of price, availability and competition would fall completely upon the contracting officers, most likely prior to issuance of a solicitation. Procuring agencies have indicated that in many cases, they do not have the expertise or resources to accomplish this. When the use of fly ash is merely solicited through a dual bid approach, however, market conditions will determine price and availability and whether a satisfactory level of competition exists. Procuring agencies can thus use this dual bid approach to ascertain availability, price, and competition for use in future solicitations.

(2) Many contractors still lack knowledge of the proper use of fly ash in concrete and of the means of ensuring quality control. Under a requirement that only bids for cement or concrete containing fly ash must be solicited, contractors inexperienced in the use of fly ash might submit a bid in order to secure award of a contract, but might be unable to provide a satisfactory product. Forcing the use of fly ash could also lead to the use of lower quality ashes which might have deleterious effects on concrete. While cement and concrete suppliers are clearly responsible both for the quality of the ingredients of their product and for meeting appropriate performance standards, simply recommending that a procuring agency solicit bids on cement or concrete containing fly ash only where it knows such cement or concrete to be reasonably available from responsible suppliers may, at least in the early stages of implementation of this program, create a more favorable atmosphere for acceptance of the product over the long term as more users gain experience with it.

(3) Requiring the use of fly ash as a partial cement replacement in cement and concrete would effectively preclude use of other recovered materials in cement and concrete. As discussed in this preamble under the section entitled "Scope," recovered materials such as iron blast furnace slag and silica fume may be used successfully in concrete, especially in the future. Although this guideline applies only to use of fly ash, the general provisions of it should be applied in those cases where other suitable recovered materials become available. Excluding such recovered materials could be a major setback to their development.

Bid Alternatives

Situations may occur where two or more low bids are received which offer different levels of fly ash content. While it generally would be desirable to make award to the bidder offering the highest fly ash content (assuming technical performance is maintained), there is a problem if that bid price is higher than that of other suppliers. To make award to the higher bidder would be contrary to certain fundamental government procurement principles.

To overcome this problem, the Agency considered establishing some type of "sliding scale" which would allow credits, and in effect additional payment for the supply of various ranges of fly ash in cement and concrete. This alternative was rejected because it seemed too cumbersome to develop and implement, because it lacked statutory authority, and because procurements made under such an approach would probably invite numerous protests from the losing bidders.

As another alternative, the Agency considered establishing a minimum level of fly ash content for those contractors wishing to supply fly ash. If the lowest costs responsible bidder offered fly ash, at least this minimum requirement of fly ash content would be necessary to be awarded the contract. The problem with this approach is that no one level of fly ash content, even a minimum level, should be established for use in all construction projects.

However, if procuring agencies desire to establish some minimum requirements, they may consider a modification of this alternative. On a project-by-project basis, a minimum level may be established based on technical performance needs, past experience, local construction practices, etc. Award would be made to the lowest priced responsible offeror, and if fly ash is used, the supplier must at least meet the minimum fly ash content established for that particular job. This minimum need not be established immediately, but may be set after sufficient experience is obtained.

Recommendations as to Price, Competition, Availability, and Performance

Prices

Section 6002 raises the issue of "reasonable" price. Congress did not say that a recovered material product need cost less than or the same as the virgin material product it replaces, but merely that its cost be reasonable. EPA feels that Congressional intent could mean that the recovered material product may in fact cost more, but not much more, than the virgin product. EPA considered setting a limit on how much more could be paid for a recovered material product, such as five percent. The Agency rejected this idea. The allowance for payment of a premium for recycled products is contrary to fundamental Federal procurement laws, which generally require that award be made to the lowest price responsible offeror. In addition, it is unnecessary since the use of fly ash in cement and concrete is itself cost competitive. No price premium should therefore be paid for cement or concrete containing fly ash. Indeed, to allow a premium may be unnecessarily inflationary.

This guideline leaves the determination of reasonable price to the discretion of the procuring agency, although the guideline does suggest general procedures for determining reasonable prices and price competition, based on procedures contained in the Federal Procurement Regulations applicable to certain types of procurements. The Agency cautions against determining reasonableness of price by comparing spot prices for relatively small quantities of cement or concrete containing fly ash with competitive bids for volume purchases of portland cement or concrete. Comments are requested on this issue of reasonable price.

Competition

The primary purpose of competition is to secure the lowest price for a given product. Federal procurement procedures state that adequate competition is usually presumed to exist if: (i) At least two responsible offerors (ii) who can satisfy the Government's requirements (iii) independently compete for a contract to be awarded (iv) by submitting priced offers responsive to the expressed requirements of a solicitation. In addition, the prices should be examined for reasonableness. Using the bid alternatives recommended by EPA, there should be no problem in achieving reasonable competition. Solicitation of fly ash bids alone is recommended only where the procuring agency is satisfied that the price of cement or concrete containing fly ash is reasonable and that the product is available. Solicitation of bids for both portland cement of concrete and cement or concrete containing fly ash is recommended in all other cases, thus enabling the procuring agency to better guarantee overall competition.

The existing Federal procurement procedures do not suggest comparing contracts with respect to numbers of bidders. They merely require that there be a sufficient number of bidders for adequate price competition for the particular contract at hand. EPA feels that as long as prices can be determined to be reasonable for cement and concrete which contain fly ash, then competition should be presumed to exist, no matter what the number of prospective offerors.

Availability and Delays

The Agency does not feel that procuring agencies should have to tolerate any unusual or unreasonable delays in obtaining cement or concrete which contain fly ash, other than delays which may be typically associated with portland cement and concrete. as specifications and purchasing practices are revised to allow for the use of fly ash, this material should become more widely available both geographically and in terms of the number of businesses willing and able to supply it.

Performance

The issue of reasonable performance is addressed in this preamble under the subsections on "Technically Proven Uses," "Specifications," and "Quality Control." Additional technical performance information is contained in the "References" section of this guideline.

In general, fly ash blended cement can be considered substitutable for all ASTM cement types except Type III, High Early Strength (and even these requirements can be met by adding, but not substituting, fly ash). However, from a practical standpoint, the use of fly ash should be determined on a job-by-job basis, as there may be specific technical applications which would preclude the use of fly ash. The purpose of comparison to "reasonable" performance standards is to eliminate those standards, specifications, procedures, and practices which are overly restrictive and which discriminate, either directly or indirectly, against the use of fly ash. The use of reasonable performance standards is also intended to assure that the necessary technical performance requirements are still maintained, and that product quality is not reduced below acceptable limits.

Time-Phasing

Although the requirements of Section 6002 and the recommendations of this guideline should be implemented as quickly as possible, the Agency recognizes that problems could occur—in both the marketplace and governmental procurement system—if implementation is pushed too rapidly. For example, the cost of fly ash suitable for use in cement and concrete could rise dramatically until the supply of suitable ash and storage capacity has a chance to increase. Construction contracts might include allowance for fly ash where it is technically inappropriate. Thus, this guideline recommends a phased-in approach to implementation.

The first year after final publication of this guideline would be reserved for specification review and revision. Beginning in the second year, procuring agencies should conform their purchases of cement or concrete to the recommendations of this guideline, in the manner discussed above.

Certification

In accordance with Section 6002 of the Act, vendors are required to certify the percentage of fly ash being included in the cement or concrete being supplied under the contract. This certification requirement is to take effect after a date to be specified in the guideline.

The exact certification procedure and language to use is in part dependent upon the bid mechanism which is employed, as discussed in this preamble under the section titled "Purchasing—Bidding Approach." For example, if fly ash is allowed and the level of fly ash content is left to the discretion of the supplier, the content level should be presented in his bid. If a minimum level of fly ash content is required, a bidder should certify that the minimum is being met, and also what percentage will actually be used. This information is not only useful in establishing future contract requirements, but is most likely a necessity in evaluating the concrete mix design.

A simple certification clause is contained in the Code of Federal Regulations, 41 CFR Part 1-1, Subpart 1-1.2504, which states:

> The offeror/contractor certifies that recovered materials will be used as required by specifications referenced in the solicitation/contract.

The opinion of the Agency is that by signing the bid document/solicitation, the cement or concrete supplier is in effect agreeing to meet the fly ash content requirements. Thus, no separate form, signature, etc. is needed.

In addition to the inclusion of such a certification clause in all solicitations, the percentage of fly ash used should normally be certified on a per project or per shipment basis, as opposed to certification of the average amount to be used over the course of a year, for instance. Except for technical performance purposes in concrete mix design, a procuring agency may allow the percentage to be certified within a small range, rather than requiring an exact percentage. The purpose of this flexibility is to not discourage potential suppliers who may be fearful that if an exact percentage is certified for a government contract, *only* that exact percentage may be supplied. Weather conditions or material variations, for example, may require modification of the concrete mix design and therefore the fly ash content.

Comment is specifically requested on the issue of certification.

Quality Control

Nothing in this certification section should be construed to relieve the contractor of responsibility for providing a satisfactory product. Cement and concrete suppliers are already responsible both for the quality of the ingredients of their product and for meeting appropriate performance requirements.

The responsibility for insuring the quality of blended cement lies with the supplier. ASTM specification C595 specifies adequate requirements for quality control of fly ash used in blended hydraulic cements. Most blended cement manufacturers maintain quality control programs. No additional testing above that which would be required of any cement should be necessary on the part of the user/builder to insure compliance with this specification. However, the user must be conscious of any differences which may exist in the field application of blended cement containing fly ash vs. portland cement.

The responsibility for insuring the quality of fly ash used as an admixture in concrete is shared by the builder and the concrete or fly ash supplier. Although many suppliers of fly ash have their own quality control program, commenters have pointed out that ASTM specification C618 may not be sufficiently stringent to ensure all ashes which comply are really suitable for general use as mineral admixtures in concrete, particularly when chemical admixtures such as air entraining agents are to be used. ASTM C618 has recently been revised and the new specification should be available in the near future.

However, there is no assurance that all ashes which comply will be suitable for all uses. Fly ash and concrete suppliers should be expected to demonstrate (through reasonable testing programs or previous experience) the performance and reliability of their product. The judgment of the builder must be used in evaluating:

(1) Whether additional testing is necessary to insure the performance of the concrete, and

(2) Whether such testing is cost effective when compared with the cost of using other materials.

Fly ash which does not satisfy at least ASTM specifications should not be used in cement or concrete on Federal construction projects.

For those agencies desiring a testing or quality assurance program for cements, blended cements, or pozzolans, the U.S. Army Engineer Waterways Experiment Station (WES), P.O. Box 631, Vicksburg, Mississippi 39180, may be contacted. WES is the agency responsible for testing such materials for Federal agencies.

Comment is requested on the issue of quality control for fly ash.

Enforcement and Monitoring

EPA expects full cooperation from all Federal Agencies in implementation of this guideline. The Office of Federal Procurement Policy (OFPP) has the major responsibility for overseeing implementation of Section 6002 of RCRA. The enforcement powers of EPA and OFPP are limited mainly to jawboning. However, given the high level of public and Congressional interest in resource recovery and energy conservation, substantial pressure may be brought to bear on organizations which fail to comly with the intent of the guideline.

The OFPP is responsible for monitoring and reporting annually to Congress on the actions taken by procuring agencies in implementing Section 6002 of RCRA. OFPP has imposed a reporting requirement upon the procuring agencies to gather this information. EPA, in conjunction with the OFPP, will monitor the impact of this particular guideline on the procurement practices of Federal agencies and on fly ash use. Should it become apparent during the next several years that this guideline has not been effective in promoting the use of fly ash, EPA may promulgate a recommendation that the use of fly ash be required.

Procuring agencies should investigate recovered material certifications if there is a doubt about their validity. This doubt could arise based upon the expert knowledge of the contracting officer, or by inquiries made by competitors about the validity of certification. Procuring agencies should also investigate claims from those desiring to supply fly ash that they may still be precluded from bidding for reasons other than technical performance requirements.

Date

EPA is charged with designating a time after publication of this guideline at which certification requirements will take effect. Certification of fly ash content should be a part of any solicitation which allows or requires the use of fly ash in cement or concrete. This guideline recommends a twelve month period after publication for review and revision of all guide and continuing contract specifications. After this twelve month period any solicitations/contracts issued should either allow or require that fly ash be supplied, and thus should incorporate certification requirements.

Regulatory Analysis

In this and other sections, the preamble contains discussions of the four elements required in a Regulatory Analysis: (1) The program objectives, (2) our consideration of regulatory alternatives, (3) a general assessment of our choices and (4) the rationale for our decision. EPA believes it is complying with the intent of Executive Order 12044 because of this and other efforts, including the preparation of more detailed background documents to support the analyses below. These documents may be examined at the U.S. E.P.A. Headquarters, Room 2416, 401, M Street, SW., Washington, D.C. 20460 and at E.P.A. Regional Libraries. If there are apparent inconsistencies between these documents and the preamble, the latter shall represent the Agency's position.

Effects

(1) *Economic savings.* This guideline should help the cement industry by reducing both energy costs and capital investment requirements for capacity expansions. Adding capacity by using fly ash to produce blended cement is a viable alternative to new kiln construction. Adding capacity with fly ash involves about ten percent of the cost of a new plant ($5–$15 per ton added capacity using fly ash vs. $125–$185 per ton for a new cement plant).

The purchased energy cost associated with cement production represents one-third of the finished value of the cement—very high in relation to other building materials. At a typical blending rate of 20 percent, fly ash in cement can reduce total energy use about 15 percent. The portion of total cost represented by this energy savings—currently five percent—will grow as the cost of purchased energy increases.

For cement consumers, i.e. ready mixed concrete producers, concrete product manufacturers, and highway contractors, fly ash can reduce raw material costs. Cement prices range from $40–$60 per ton, while fly ash suitable for use in concrete may range from $15–$50 per ton. Depending on the replacement rate and relative price of the two materials, substituting fly ash can save 5 to 15 percent of the cost.

Procuring agencies may not be in a position to realize the savings described here. Because of the pricing structure and concentrated nature of the cement industry—and the fact that a properly blended cement containing fly ash performs as well or better than portland cement—blended cements containing fly ash (ASTM Types IP and I(PM)) may be priced at the same level as ASTM Type I portland cement. However, concrete producers are able to take direct advantage of decreased raw materials cost by purchasing fly ash as a partial cement replacement. Given the greater competition among the large number of firms in these industries, bid quotations for concrete may reflect part of these savings.

(2) *Energy Conservation.* In 1976, the portland cement industry accounted for two percent of total energy used by U.S. industry. Although the cement industry has steadily reduced its energy consumption per unit of product over the past several years, the use of fly ash in producing blended cements can still save a significant amount of energy.

Seventy to eighty percent of the energy used in cement production is consumed during the pyroprocessing stage, where raw materials are subjected to intense heat and chemically react to form cementitious compounds, or clinker. The clinker is ground into the fine powder known as cement. Replacing the cement clinker with fly ash (on a one-to-one ratio by weight) reduces the amount of clinker production required per ton of finished cement. Energy savings are proportioned to the percentage of fly ash used in the blend. Assuming a twenty percent replacement rate, the savings may range from about 13 to 19 percent of total energy used in production.

Concrete producers can save energy indirectly if fly ash is used as an admixture at their plant. Replacing a portion of cement with fly ash in the final product would reduce the production needed from the cement industry, and thus would reduce energy consumption. Each ton of cement replaced would save approximately 5,750,000 BTUs of energy.

(3) *Environmental Issues.* (a) *Benefits.* The use of fly ash in cement and concrete will have a positive effect on the environment, reducing pollution of

the land, air, and water. It will do this by reducing (1) the quantities of fly ash requiring disposal, (2) the mining and processing of raw materials used in cement production, and (3) the cement plant emissions per ton of blended cement produced or per ton of cement replaced with fly ash.

If current usage rates continue, by 1985 60–65 million tons of fly ash annually will require disposal. Approximately 10–20 million tons of this fly ash are estimated to be suitable for use in concrete. This guideline can affect the practices of collecting fly ash, especially from new sources, and can reduce the quantities which require ultimate disposal. Thus, the use of fly ash in cement and concrete will provide a more environmentally acceptable way to manage these substances than would otherwise be available.

Current practices for cement manufacturing, and current disposal practices for fly ash, can have a negative effect on air quality (increased dust), water quality (surface and groundwater contamination), land use, noise, and aesthetic value. The use of fly ash in cement and concrete can reduce these effects in several ways. For example, it would reduce the need for such raw materials as limestone and clay, whose mining and processing can harm the environment.

Requiring less cement for the same quantity of "cementitious" end product may reduce the amount of cement kiln dust which requres disposal (currently 6–8 million tons per year). The disposal of cement kiln dust can have the same harmful effects as the disposal practices of fly ash. In addition, using fly ash to increase the capacity of a cement plant would most likely reduce the need for air pollution control since it would not require the air pollution control associated with new kiln construction. This approach to expanding capacity may be especially attractive in "nonattainment" areas, where new kiln construction is effectively precluded.

(b) *Impact of RCRA, Subtitle C.* In May 1980, EPA promulgated regulations for the control of hazardous waste pursuant to Subtitle C of RCRA. Little, if any, fly ash exhibits characteristics defined as hazardous in these regulations. Therefore, Subtitle C regulations will have no significant impact on the use of fly ash in cement and concrete. At the same time as the original proposal of the hazardous wastes regulations (December 18, 1978), EPA issued an advance notice of proposed rulemaking that it was considering establishing 5 pCi/g of radium-226 as a criterion for listing wastes as hazardous. The notice also requested comment on other criteria which might tend to affect the radiation hazard. Among these is the emanation rate of radon from the waste. The Agency has at this date taken no further action on this proposed rulemaking to establish general criteria for hazardous radioactivity levels in wastes.

Where resource recovery is practiced, another important consideration in assessing the hazard is the proposed use of the waste material. While a significant proportion of fly ash generated in the U.S. has more than 5 pCi/g of radium-226, the physical structure of fly ash is such that its contribution to radiation exposure is probably less than that of most normal constituents of concrete which generally fall below this level. This is explained in subparagraph (c).

(c) *Radioactivity Issues.* Several groups have expressed concern to EPA that fly ash used in the construction of habitable structures could pose a threat to public health due to radioactivity. The source of the radiation threat is due to radium-226, a radioactive isotope which occurs naturally in soil, sand, and mineral deposits as well as in fly ash. The radium-226 content of soil generally ranges from .2 to 3 picocuries per gram (pCi/g). Limited measurements of radioactivity in cement show that the radium-226 content of cement can be as high as 5 pCi/g, but typically averages close to 1 pCi/g. Limited measurements of fly ash presently generated in the U.S. show a radium-226 content ranging from 1 to 8 pCi/g with an average of roughly 4 pCi/g.

There are two pathways of radiation exposure from radium-226 in building materials. The pathway of primary concern is from inhalation of radon-222 and its short-lived decay products. Radon-222, an inert gas with a radioactive half-life of 3.8 days, is the first generation decay product of radium-226. Because it is an inert gas, it can readily migrate from the building material into the indoor air of a home. Although the rate at which radon is created within a building material is proportional to its radium content, the intrinsic structure of the material may, in some cases, prevent most of the radon from escaping. When air containing radon and its radioactive decay products is breathed for long periods of time, a person's risk of lung cancer is increased. Gamma radiation from radium-226 and its decay products is the other exposure pathway. The amount of gamma radiation emission from a building material is proportional to its radium content, but the total exposure a person receives will also depend on other factors such as shielding, distance from the material, and exposure time. Exposure to gamma radiation results in an increased risk of many types of cancer.

When fly ash is used as a patial cement replacement in concrete, the fly ash content of the final concrete product is between 2 and 3 percent (assuming a 15 to 25 percent cement replacement rate and an 8 to 1 ratio of aggregate and water to cementious material). Since the average radium-226 content of fly ash exceeds that of cement by a few pCi/g, the use of fly ash as a cement replacement in habitable structures will, on the average, result in a slight increase in the gamma radiation exposure to people (less than a milliroentgen per year). However, in some instances, where fly ash with a lower than average radium content replaces a cement with a higher than average radium content, the result would be less gamma radiation exposure.

The use of fly ash as a cement replacement will also affect the quantity of radon emitted by the building material. Although the rate at which radon is created is directly proportional to the radium content, other factors may inhibit radon emanation from a material. Because fly ash is produced at high temperatures, it has a glassy structure which keeps most of the radon from escaping. The fraction of radon which escapes from fly ash (emanation fraction) has been measured at no more than a few percentage points. In contrast, typical soil and soil like materials tend to have an emanation fraction in the neighborhood of 20%. Thus, although fly ash, on the average, has a greater radium content than the cement it replaces, the use of fly ash as a partial cement replacement is likely to reduce the radon gas contribution of the final concrete product. EPA is presently investigating this issue more thoroughly.

While fly ash use in cement would, on the average, result in a small increase in gamma radiation exposure, this small increase in gamma hazard is likely to be offset by a decreased radon hazard. In light of this, EPA believes that the use of typically-occurring fly ash in concrete does not constitute a significantly different radiation risk than the risk from the cement it replaces, and neither of these is significantly different from the radiation risk posed by common soil.

Institutional Issues

In spite of proven technical performance and favorable economics, the use of fly ash in cement and concrete has had only limited acceptance. This can be attributed in part to potential consumers' unfamiliarity with fly ash, and their resistance to the use of a new product where an existing product—in this case portland cement—has traditionally been accepted. In some cases there may be outright discrimination against this use of fly ash, because of attitudes, personalities, and political and economic pressure.

It is difficult to obtain quick approval for a new product or material specification in the construction field, given the requirements for experimentation, demonstration, field evaluation and finally specification changes. However, it should be recognized that fly ash has already gone through these steps. There are established specifications and standards for the testing and use of this material. Sources of ash must be acceptable and EPA emphasizes that only ash which meets established specifications should be used. However, a procuring agency need not "reinvent the wheel" by requiring extensive and expensive reevaluation of the basic feasibility which has already been proven. This applies to all government agencies, but especially to state and local entities which use such instruments as building codes, to regulate construction activities.

Design engineers generally have the final say on the materials to be specified for a particular construction job. Typically, until a majority of peer engineers accept a "new" material there is reluctance to use it. However, an engineer can meet his or her responsibility for the performance of a structure by conducting a thorough review of the concrete mix design before placing the concrete, and assuring that the materials and mix design meet, as a minimum, ASTM, Federal, and/or American Concrete Institute specifications. The intent of this guideline is to help overcome certain of these "institutional" barriers which may have no adequate foundation.

Resource Requirements

The cost to procuring agencies of compliance with this guideline with be minimal. The price of cement and concrete containing fly ash should be less than or equal to the price of portland cement and concrete. The start-up costs of revising specifications and assimilating fly ash into the procurement system should be relatively minor but are not readily measurable.

The Office of Federal Procurement Policy (OFPP) is responsible for submitting an annual report to Congress on actions taken by Federal agencies and the progress made in implementation of the resource recovery policy of Section 6002. As a result, OFPP already requires an annual report from each Federal agency on actions taken in the implementation of Section 6002. By working closely with OFPP, information relevant to the implementation of this guideline can be obtained. Although EPA and OFPP are responsible for implementing and monitoring compliance with this guideline, the Agency believes an extensive enforcement system is unwarranted, since the responsibility for compliance lies with Federal agencies subject to RCRA requirements. Therefore, the costs to OFPP and EPA of implementing this guideline are expected to be relatively minor.

A total of .3 man-years of effort per year will be required of EPA during the five years following promulgation of the final guideline (1.5 man-years total). This effort will focus on implementation of guideline recommendations at the Federal, State, and local level, monitoring the impact of the guideline, and making any necessary formal revisions to the guideline language.

Public Participation

An interagency work group, including representatives from most of the Federal agencies which will be directly impacted by this guideline, assisted in its development. In addition, a draft of the guideline package, including a summary development plan, preamble, rule, and background documents was circulated to well over 200 interested persons for comment.

The major issues of concern of the work group and commenters were: (a) Requiring vs. allowing for the use of fly ash, (b) responsibility for quality control and performance of fly ash, (c) the potential health effects of the use of fly ash as a building material. These issues, among others, are discussed in detail in this Preamble.

Evaluation Plan

Executive Order 12044 requires that each new significant regulation have a plan for evaluating its effectiveness with five years of implementation. Such evaluation could, for example, lead to modification and improvement of the regulation. An evaluation plan will be prepared for this guideline prior t its final promulgation.

Dated: November 13, 1980.

Douglas M. Costle,

Administrator.

Title 40 CFR is amended by adding a new Part 249 to read as follows:

PART 249—GUIDELINE FOR FEDERAL PROCUREMENT OF CEMENT AND CONCRETE CONTAINING FLY ASH

Authority: 42 U.S.C. 6962.

Subpart A—Purpose, Applicability, and Definitions

§ 249.01 Purpose.

(a) The purpose of the guideline is to assist procuring agencies in the procurement of cement and concrete which contain fly ash, in accordance with Section 6002(e) of the Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act of 1976, as amended ("RCRA" or "Act") (42 U.S.C. 6962).

(b) This guideline contains recommendations for use in implementing Section 6002 requirements, including revision of specifications, purchasing, phasing-in of requirements, and certification procedures.

§ 249.02 Designation.

Fly ash used in cement and concrete it hereby designated by EPA as a product area for which affirmative procurement actions are required on the part of procuring agencies, under the requirements of Section 6002 of RCRA.

MSD 000603

§ 249.03 RCRA requirements pertaining to fly ash.

RCRA requires action on the part of procuring agencies with regard to revising specifications and initiating an affirmative purchasing program for recovered materials.

(a) In accordance with the requirements Section 6002(d)(1) and (d)(2) of RCRA, all federal agencies which have responsibility for drafting or reviewing specifications for cement or concrete, or construction activities involving the use of cement or concrete, must:

(1) Eliminate from these specifications:

(i) Any exclusion of fly ash as a component in cement or concrete, and

(ii) Any requirements, either direct or indirect, that the items be manufactured from virgin materials.

(2) Assure that these specifications require the use of fly ash to the maximum extent practical, without jeopardizing the final cement or concrete product.

The requirements of paragraph (a)(1) of this section apply in all cases except those in which it can be demonstrated that performance standards would not be satisfied. However, if performance standards are so stringent that they effectively and arbitrarily exclude fly ash, the performance standards must be revised.

(b) In accordance with the requirements of Section 6002(c)(1) of RCRA, procuring agencies must purchase cement and concrete which contain fly ash unless a determination has been made that (1) cement or concrete containing fly ash will not be available within a reasonable period of time, or (2) this cement or concrete is only available at an unreasonable cost, or (3) the purchase will result in a level of competition which is less than satisfactory, or (4) the cement or concrete will not meet reasonable performance standards.

(c) In accordance with the requirements of Section 6002(c)(3) of RCRA, contracting officers must require that vendors certify the percentage of fly ash which is being incorporated in the cement or concrete which they supply. This requirement takes effect after the date specified in § 249.34.

§ 249.04 Applicability.

(a) This guideline applies to all procuring agencies and to all procurement actions involving cement or concrete where the procuring agency purchases in total $10,000 or more worth of cement or concrete (including related services such as placing and finishing) during the course of a fiscal year, or where the quantity of such items purchased during the preceding fiscal year was $10,000 or more.

(b) Procurement actions include all purchases for cement or concrete made directly by a procuring agency or by any person directly in support of work being performed for a procuring agnecy, as in the case of general construction contractors and/or subcontractors.

(c) This guideline also applies to any purchases of cement or concrete made "indirectly" by a procuring agency, as in the case of purchases resulting from grants, loans, funds, and similar forms of disbursements of monies which the procuring agency intended to be used for construction.

(d) The guideline does not apply tp purchases of cement and concrete which are not the direct result of a contract, grant, loan, funds disbursement, or agreement with a procuring agency.

§ 249.05 Definitions.

As used in this guideline:

(a) "Act" or "RCRA" means the Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act of 1976, as amended, 42 U.S.C. section 6901 et seq.

(b) "Construction" means the erection or building of new structures, or the replacement, expansion, remodeling, alteration, modernization, or extension of existing structures. It includes the engineering and architectural surveys, designs, plans, working drawings, specifications, and other actions necessary to complete the project.

(c) "Contract specifications" means the set of specifications prepared for an individual construction project, which contains design, performance, and material requirements for that project.

(d) "Federal agency" means any department, agency, or other instrumentality of the Federal Government, any independent agency or establishment of the Federal Government including any Government corporation, and the Government Printing Office (Pub. L. 94-580, 90 Stat. 2799, 42 U.S.C. 6903).

(e) "Fly ash" means the component of coal which results from the combustion of coal, and is the finely divided incombustible mineral residue which is typically collected from boiler stack gases by electrostatic precipitator or mechnical collection devices.

(f) "Guide specification" means a general specification—often referred to as a design standard or design guideline—which is a model standard and is suggested or required for use in the design of all of the construction projects of an agency.

(g) "Implementation" means putting a plan into practice by carrying out planned activities, or ensuring that these activities are carried out.

(h) "Material specification" means a specification that stipulates the use of certain materials to meet the necessary performance requirements.

(i) "Person" means an individual, trust, firm, joint stock company, Federal agency, corporation (including a government corporation), partnership, association, State, municipality, commission, political subdivision of a State, or any interstate body

(j) "Procurement item" means any device, good, substance, material, product, or other item whether real or personal property which is the subject of any purchase, barter, or other exchange made to procure such item (Pub. L. 94-580, 90 Stat. 2800, 42 U.S.C. 6903).

(k) "Procuring agency" means any Federal agency, or any State agency or agency of a political subdivision of a State which is using appropriated Federal funds for such procurement, or any person contracting with any such agency with respect to work performed under such contract (Pub. L. 94-580, 90 Stat. 2800, 42 U.S.C. 6903).

(l) "Recovered material" means material which has been collected or recovered from solid waste.

(m) "Sludge" means any solid, semisolid or liquid waste generated from municipal, commercial, or industrial wastewater treatment plant, water supply treatment plant, or air pollution control facility, exclusive of the treated effluent from a wastewater treatment plant.

(n)(1) "Solid waste" means any garbage, refuse, sludge or any other waste material which is not excluded under paragraph (n)(6) of this section.

(2) An "other waste material" is any solid, liquid, semisolid or contained gaseous material, resulting from industrial, commercial, mining or agricultural operations, or from community activities which:

(i) Is discarded or is being accumulated, stored or physically, chemically or biologically treated prior to being discarded; or

(ii) Has served its original intended use and sometimes is discarded; or

(iii) Is a manufacturing or mining by-product and sometimes is discarded.

(3) A material is "discarded" if it is abandoned (and not used, reused, reclaimed or recycled) by being:

(i) Disposed of; or

(ii) Burned or incinerated, except where the material is being burned as a fuel for the purpose of recovering usable energy; or

(iii) Physically, chemically, or biologically treated (other than burned or incinerated) in lieu of or prior to being disposed of.

(4) A material is "disposed of" if it is discharged, deposited, injected, dumped, spilled, leaked or placed into or on any land or water so that such material or any constituent thereof may enter the environment or be emitted into the air or discharged into ground or surface waters.

(5) A "manufacturing or mining by-product" is a material that is not one of the primary products of a particular manufacturing or mining operation, is a secondary and incidental product of the particular operation and would not be solely and separately manufactured or mined by the particular manufacturing or mining operation. The term does not include an intermediate manufacturing or mining product which results from one of the steps in a manufacturing or mining process and is typically processed through the next step of the process within a short time.

(6) The following materials are not solid wastes for the purpose of this part:

(i) (A) Domestic sewage; and

(B) Any mixture of domestic sewage and other wastes that passes through a sewer system to a publicly-owned treatment works for treatment. "Domestic sewage" means untreated sanitary wastes that pass through a sewer system

(ii) Industrial wastewater discharges that are point source discharges subject to regulation under Section 402 of the Clean Water Act, as amended.

(Comment: This exclusion applies only to the actual point source discharge. It does not exclude industrial wastewaters while they are being collected, stored or treated before discharge, nor does it exclude sludges that are generated by industrial wastewater treatment)

(iii) Irrigation return flows.

(iv) Source, special nuclear or by-product material as defined by the Atomic Energy Act of 1954, as amended, 42 U.S.C. 2011 et seq.

(v) Materials subjected to in-situ mining techniques which are not removed from the ground as part of the extraction process.

(o) "Specification" means a clear and accurate description of the technical requirement for materials, products, or services, which specifies the minimum requirement for quality and construction of materials and equipment necessary for an acceptable product. In general, specifications are in the form of written descriptions, drawings, prints, commercial designations, industry standards, and other descriptive references.

Subpart B—Specifications

§ 249.10 Recommendations for material specifications.

(a) In material specifications, maximum use should be made of existing Federal specifications and voluntary consensus standards for cement and concrete which contain fly ash. These are:

(1) *Cement.* (i) ANSI/ASTM C595—"Standard Specification for Blended Hydraulic Cements."

(ii) Fed. Spec. SS-C-1960/4B—"Cement, Hydraulic, Blended."

(2) *Concrete.* (i) ANSI/ASTM C618—"Standard Specification for Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete."

(ii) Fed. Spec. SS-C-1960/5A—"Pozzolan, For Use in Portland Cement Concrete."

(iii) ANSI/ASTM C311—"Standard Methods of Sampling and Testing Fly Ash and Natural Pozzolans for Use as a Mineral Admixture in Portland Cement Concrete."

(b) Concrete specifications which specify minimum cement content could potentially discriminate against the use of fly ash. Such specifications should be changed in order to allow the substitution of fly ash for cement in the concrete mixture.

§ 249.11 Recommendations for guide specifications.

(a) Each procuring agency should assure that its guide specifications do not discriminate againt the use of fly ash in cement and concrete. Each procuring agency should:

(1) Revise specifications, standards, or procedures which currently require that cement and concrete contain virgin materials to eliminate this restriction.

(2) Revise specifications, standards, or procedures which prohibit using recovered materials (particularly fly ash) in cement and concrete to eliminate this restriction.

(b) Guide specifications should require that contract specifications for individual construction projects allow for the use of fly ash, unless fly ash use is technically inappropriate for a particular construction application.

(c) Referenced specifications which are maintained by national organizations, such as the American Association of State Highway and Transportation Officials (AASHTO) and the American Concrete Institute (ACI) should be modified, if necessary, to remove any discrimination against the use of fly ash in cement and concrete.

(d) Guide specifications should be revised, if necessary, within six months after the date of publication of this guideline, to incorporate the recommendations of paragraph (a) through (c) of this section.

§ 249.12 Recommendations for contract specifications.

(a) "Contract" specifications, which are prepared either by or for a procuring agency for each individual construction project, should allow the use of cement and concrete which contains fly ash as an alternate material for the project in accordance with § 249.10, except as noted in paragraph (b) of this section.

(b) Contract specifications should not allow the use of fly ash if it can be demonstrated that, for a particular project or application, reasonable performance requirements for the cement or concrete will not be met, or that the use of fly ash would be inappropriate for technical reasons. The demonstration under this paragraph should be documented by the procuring agency, design engineer/architect, or other responsible person, based on specific technical performance information.

(c) The procuring agency should assure that contract specifications reflect the provisions of paragraphs (a) and (b) of this section by reviewing the contract specification for any individual construction project before awarding the contract. These requirements apply to projects which are contracted for directly, as well as those projects directly performed under the provisions of grants, loans, funds, or similar forms of disbursement.

(d) All contract specifications issued after one year from the date of publication of this guideline should meet the provisions of this section.

§ 249.13 Recommendations for fly ash content and mix design.

(a) No minimum or maximum level of fly ash content is specified for all uses, due to variations in fly ash, cement, strength requirements, costs, etc. However, replacement rates of fly ash for cement in the production of blended cement generally do not exceed 20% to 30%, with 15% being a more accepted rate when fly ash is used as an admixture in concrete. Fly ash blended cements may range from 0%–40% fly ash by weight, according to ASTM C595, for Types IP and I(PM).

(b) Information on fly ash and concrete mix design are contained in the "References" section of this guideline. These sources should be consulted in the design and evaluation of the proper mix ratio for a specific project. In general, the concrete mix is adjusted by adding fly ash, while decreasing cement, water, and fine aggregate. The fly ash should be checked for compliance with applicable ASTM standards/Federal specifications, and trial mixes should be made to verify compliance of such mixes with specified quality parameters. Only fly ash which, as a minimum, meets ASTM standards should be used.

§ 249.14 Recommendations for performance standards.

(a) Performance standards relating to cement or concrete construction projects should not restrict the use of fly ash, either directly or indirectly, unless this restriction is justified on a case-by-case basis.

(b) A performance standard which would restrict the use of fly ash is one which requires higher strengths in shorter periods of time than are actually necessary to comply with design criteria. Some alternatives which should be considered, on a project-by-project basis, include:

(1) Evaluating pavement strengths for roads on the basis of 28 day strengths instead of 14 days strengths.

(2) Evaluating airfield pavement strengths on the basis of 90 day strengths instead of 28 day strengths.

(3) Evaluating building structure strengths on the basis of the number of days until full-loading (typically 90–120 days).

Extension of strength evaluation periods can only be made where curing conditions are such that strength gaining reactions are still able to take place in the concrete over an extended period of time.

Subpart C—Purchasing

§ 249.20 Recommendations on bidding approach.

(a)(1) EPA recommends that a procuring agency solicit bids both for cement or concrete which contain fly ash and for portland cement or concrete, except as provided for in § 249.12(b).

(2) With this approach, award should be made to the lowest priced responsible bidder, regardless of whether fly ash is used. In the event that two or more low bids are received which offer different levels of fly ash content, award should be made to the lowest priced responsible offeror. In the case of identical low bids, award should be made to the offeror with the higher level of fly ash content.

(b)(1) Alternatively, when in the judgement of the procuring agency cement or concrete containing fly ash is reasonably available and its bid price will be competitive with that of portland cement or concrete, only bids for cement or concrete containing fly ash should be solicited, except as provided for in § 249.12(b).

(2) With this approach, award should be made to the lowest priced responsible offeror, provided that fly ash is used. In the case of identical low bids award should be made to the responsible offeror with the higher level of fly ash content.

§ 249.21 Recommendations for reasonable price.

(a) General procedures, such as those contained in the Federal Procurement Regulations, should be used in determining whether the prices offered are reasonable. This determination should consider the objectives of Section 6002 of RCRA.

(b) Techniques of price analysis (not cost analysis) should be used, as appropriate. (Price analysis is the process of examining and evaluating a prospective price without evaluating the separate cost elements and proposed profit of the individual prospective supplier.) Price analysis may be done in various ways, including:

(1) Comparison of the price quotations submitted.

(2) Comparison of prior quotations and contract prices with current quotations for the same or similar end items, making appropriate allowances for any differences in quantities, delivery time, inflation, etc.

(3) Comparison of prices set forth in published price lists or catalogs.

§ 249.22 Recommandations for reasonable competition.

(a) There is reasonable competition if there is adequate price competition.

(b) Adequate price competition is usually presumed to exist if:

(1) At least two responsible offerors,

(2) Who can satisfy the purchaser's (e.g., the Government's) requirements,

(3) Independently compete for a contract to be awarded,

(4) By submitting priced offers responsive to the expressed requirements of a solicitation.

In addition, the reasonableness of prices should be evaluated in accordance with § 249.12.

§ 249.23 Reasonable availability.

Cement or concrete which contain fly ash should be considered reasonably available if there are no unusual or unnecessary delays expected in its delivery compared to that for portland cement or concrete.

§ 249.24 Recommendations for time-phasing.

In order to minimize any adverse effects on the marketplace or on the procuring agency in implementing this guideline, the Agency recommends the following timetable for implementation:

(a) The first year after publication of the guideline should be used for review/revision of all applicable specifications and standards.

(b) Not later than the beginning of the second year, all contracts should allow for or require the use of fly ash, in accordance with the provisions of §§ 249.12 and 249.20.

Subpart D—Certification

§ 249.30 Recommendations for measurement.

(a) Measurement of fly ash content should be made in accordance with standard industry practice, normally on a weight basis, and stated as a percentage of the weight of total cementitious material: [fly ash weight ÷ (fly ash weight + cement weight)] = %. This will often be a reflection of either a typical cubic yard of concrete or ton of cement.

(b) The supplier should be required to certify:

(1) The percentage which will be used in a particular mix design, or

(2) The use of any minimum percentage requirement which may have been established for a particular contract.

§ 249.31 Recommendations for documentation.

(a) Certification of fly ash content by the cement or concrete supplier should not require separate reporting forms, but should use existing mechanisms, such as a statement contained in a signed bid document or a mix design proposal.

(b) In cases where the purchase of cement or concrete is made by a contractor or by any authority other than the procuring agency, the fly ash content of the cement or concrete purchased and quantity of fly ash used should be made available to the procuring agency.

§ 249.32 Quality control.

(a) Nothing in this guideline should be construed to relieve the contractor of responsibility for providing a satisfactory product. Suppliers of blended cement, fly ash, and concrete should be expected to demonstrate (through reasonable testing programs or previous experience) the performance and reliability of their product. Cement and concrete containing fly ash should not be subjected to any unreasonable testing requirements.

(b) Agencies desiring a testing or quality assurance program for cements, blended cements, or fly ash should contact the U.S. Army Engineer

Waterways Experiment Station, P.O. Box 631, Vicksburg, Mississippi 39180.

§ 249.33 **Enforcement.**

Procuring agencies should consider and investigate inquiries received from a supplier's competitors which raise reasonable doubt about the legitimacy of fly ash certification.

§ 249.34 **Date recommendations.**

Certification of fly ash content should occur at the time of purchase of cement and concrete in accordance with the phasing in recommendations in § 249.24.

References

EPA recommends that these documents be used by procuring agencies and those persons wishing to familiarize themselves with issues related to fly ash use.

1. ASTM. Standard specification for fly ash and raw or calcined natural pozzolan for use as a mineral admixture in portland cement concrete. ASTM C618, latest edition. Annual book of ASTM standards, part 14. Philadelphia, PA.
2. ASTM. Standard methods on sampling and testing fly ash or natural pozzolans for use as a mineral admixture in portland cement concrete. ASTM C311, latest edition. Annual book of ASTM standards, part 14. Philadelphia, PA.
3. ASTM. Standard specification for blended hydraulic cements. ASTM C595, latest edition. Annual book of ASTM Standards, part 14. Philadelphia, PA.
4. Brown, P., U. Clifton, and G. Frohnsdorff. National Bureau of Standards. 1976. The utilization of industrial by-products in blended cements. Proceedings. Fifth Mineral Waste Utilization Symposium, pp. 278–284.
5. Department of the Army, Corps of Engineers, Office of the Chief of Engineers, Washington, D.C. Standard practice for concrete. EM–1110–2–2000, with latest changes.
6. Department of the Army, Corps of Engineers, Office of the Chief of Engineers, Washington, D.C. Guide Specification for concrete. CW–03305, with latest changes.
7. Department of the Army, Corps of Engineers, Office of the Chief of Engineers, Washington, D.C. Guide specification for cast-in-place structural concrete. CW–03301, with latest changes.
8. General Services Administration. Specification for pozzolan for use in portland cement concrete. Federal specification SS–C–1960/5A.
9. General Services Administration. Specification for blended hydraulic cement. Federal specification SS–C–1960/4B.
10. Gordian Associates, Inc. 1978. Potential for energy conservation through the use of slag and fly ash in concrete. DOE report SAN–1699–T1.
11. Lovewell, C. E., and E. J. Hyland. 1974. A method of proportioning structural concrete mixtures with fly ash and other pozzolans. ACI Committee 211, "Proportioning Concrete Mixes," SP–46–8: pp. 109–140 (with 9 references).
12. Tennessee Valley Authority; Singleton Materials Engineering Laboratory. 1979. Properties and use of fly ash in portland cement concrete. Technical report CR–78–2 (with 11 references).

[FR Doc. 80–36048 Filed 11–19–80; 8:45 am]
BILLING CODE 6560–30–M

MORRIS BAN LEADS TO SUIT, COUNTERSUIT

The owner of the spent nuclear fuel site at Morris, Ill., and one of its major customers, have filed suit against the state of Illinois for banning out-of-state shipments of waste to the facility. That action, taken in U.S. District Court, comes shortly after the Illinois legislature approved the ban by overriding a veto by Gov. James Thompson.

General Electric Co., which owns the facility, and Southern California Edison Co., a customer, are charging that they have already agreed to allow the utility to ship waste from its San Onofre nuclear plant in 1981, but now will be unable to. The parties are charging the ban is unconstitutional because it unfairly interferes with the flow of interstate commerce.

Shortly after that suit was filed, the state of Illinois filed a suit alleging that Southern California Edison Co. plans to ship 32 tons of nuclear waste to the Morris, Ill., site and saying such shipments must be stopped. Southern California Edison denies the charge, and says in its suit the new Illinois suit is unconstitutional.

* * *

TONS OF NUCLEAR WASTE NOW RESTING OFF ATLANTIC COAST, PILOT REVEALS

Tons of nuclear waste are now resting about 100 miles off the coast of Atlantic City, N.J., a retired Navy pilot has told *United Press International*. On three occasions -- Oct. 16, 20 and 22, 1947 -- Lt. Commander George Earle and his crew dumped canisters that Earle believes contained nuclear wastes produced from the fledgling nuclear test program.

Earle broke a 33-year silence to tell the story because he was disturbed by reports in the media earlier this year concerning nuclear waste in the waters off the coast of California. Earle said each of the three missions was top secret, and he found that none had been officially logged.

While Earle characterized himself in the *UPI* story as a major nuclear proponent, he said he went public with the information because of the government's lack of concern for the safety of its citizens. The Pentagon had no immediate comment on Earle's revelations.

* * *

WITH LITTLE FANFARE, CARTER SIGNS WASTE BILL

President Carter Dec. 22 signed the "Nuclear Waste Policy Act" into law. There was no Presidential statement accompanying the signing. The bill -- which was a vastly reduced version of originally proposed nuclear waste legislation -- allows the states to have responsibility for disposing of low level waste generated within their borders, and encourages them to form regional compacts for that purpose. The legislation included various recommendations made by the State Planning Council.

* * *

SEA MAY BE BURIAL GROUND FOR NAVY'S NUCLEAR SUBS

The Navy is considering a plan where it would sink old nuclear submarines to the bottom of the ocean as a way of disposing of them, according to a recent study. The Navy would take its five decommissioned nuclear-powered submarines, remove the fuel for reprocessing, then tow the vessels to deep areas, flood, and sink them. The other alternative to the plan, according to the report, would be to remove reactors from the submarines and bury them on land.

* * *

A BELGIAN AND AN AMERICAN COMPANY HAVE ANNOUNCED THEY will jointly market an integrated system for reducing and embedding nuclear waste. Liquid radioactive waste is first dehydrated and resulting powder embedded in a solidifying substance, according to the technique. The resulting product is then placed in storage barrels which can be immersed, buried or stored at ground level. The companies, Belgo-Nucleaire and American Chem-Nuclear Systems, hope to market the product in the U.S., Taiwan, South Korea and Phillipines.

Sanitary District of Rockford

3333 Kishwaukee Street · P. O. Box 918 · Rockford, IL 61105 · 397-9700

November 12, 1980

Bernard Rains, P.E.
Manager Industrial Pollution Control
Metropolitan St. Louis Sewer District
10 E. Grand Avenue
St. Louis, Missouri 63147

BR 11/17/80

Dear Bernard:

Please find enclosed the test results of radium - 226 analysis of the District's incinerated ash and also of the vacuum filter sludge cake. If you should have any questions regarding this matter, please do not hesitate to call.

Sincerely,

SANITARY DISTRICT OF ROCKFORD

Richard W. Eick

Richard W. Eick
Plant Operations Manager

RWE/ra

cc: J. Olson
File

Enclosure

HAZLETON
ENVIRONMENTAL SCIENCES CORPORATION
1500 FRONTAGE ROAD, NORTHBROOK, ILLINOIS 60062, U.S.A

RECEIVED NOV 07 1980 SANITARY DISTRICT OF ROCKFORD

November 4, 1980

Ms. Violet Chen
Chief Chemist
Sanitary District of Rockford
3333 Kishwaukee Street
P. O. Box 918
Rockford, Illinois 61105

Dear Ms. Chen:

The following are the results of radium-226 analysis in incinerated ash and vacuum sludge cake samples received September 24, 1980.

Sample Description	Date Received	Lab Code	Ra-226 (pCi/g dry)
Vacuum sludge cake	9-24-80	SPS-420	9.2±0.1
Incinerated ash	9-24-80	SPS-421	7.2±0.2

The error given is the probable counting error at the 95% confidence level.

The purchase order was not enclosed with the cover letter. Please send us a P.O. for $148.00 for our billing.

If you have any questions concerning the results, please do not hesitate to call.

Sincerely yours,

C. R. Marucut

C. R. MARUCUT
Group Leader
Nuclear Sciences

CRM:als

I talked with Kyle wan 11/7/80 and he will send a copy of our P.O. to C.R. Marcut today.
P. Howell

PART 20 STANDARDS FOR PROTECTION AGAINST RADIATION

AUTHORITY: The provisions of this Part 20 issued under secs. 53, 63, 65, 81, 103, 104, 161, 68 Stat. 930, 933, 935, 936, 937, 948, as amended; 42 U.S.C. 2073, 2093, 2095, 2111, 2133, 2134, 2201. For the purposes of sec. 223, 68 Stat. 958, as amended; 42 U.S.C. 2273, §§20.401-20.409, issued under sec. 161 o., 68 Stat. 950, as amended; 42 U.S.C. 2201 (o). Secs. 202, 206, Pub. L. 93-438, 88 Stat. 1244, 1246 (42 U.S.C. 5842, 5846).

40 FR 8774

§ 20.1 Purpose.

(a) The regulations in this part establish standards for protection against radiation hazards arising out of activities under licenses issued by the Nuclear Regulatory Commission and are issued pursuant to the Atomic Energy Act of 1954, as amended, and the Energy Reorganization Act of 1974.

25 FR 10914

(b) The use of radioactive material or other sources of radiation not licensed by the Commission is not subject to the regulations in this part. However, it is the purpose of the regulations in this part to control the possession, use, and transfer of licensed material by any licensee in such a manner that exposure to such material and to radiation from such material, when added to exposures to unlicensed radioactive material and to other unlicensed sources of radiation in the possession of the licensee, and to radiation therefrom, does not exceed the standards of radiation protection prescribed in the regulations in this part.

40 FR 58847

(c) In accordance with recommendations of the Federal Radiation Council, approved by the President, persons engaged in activities under licenses issued by the Nuclear Regulatory Commission pursuant to the Atomic Energy Act of 1954, as amended, and the Energy Reorganization Act of 1974 should, in addition to complying with the requirements set forth in this part, make every reasonable effort to maintain radiation exposures, and releases of radioactive materials in effluents to unrestricted areas, as low as is reasonably achievable. The term "as low as is reasonably achievable" means as low as is reasonably achievable taking into account the state of technology, and the economics of improvements in relation to benefits to the public health and safety, and other societal and socioeconomic considerations, and in relation to the utilization of atomic energy in the public interest.

40 FR 8774

§ 20.2 Scope.

The regulations in this part apply to all persons who receive, possess, use, or transfer material licensed pursuant to the regulations in Parts 30 through 35, 40, or 70 of this chapter, including persons licensed to operate a production or utilization facility pursuant to Part 50 of this chapter.

§ 20.3 Definitions.

(a) As used in this part:

(1) "Act" means the Atomic Energy Act of 1954 (68 Stat. 919) including any amendments thereto;

(2) "Airborne radioactive material" means any radioactive material dispersed in the air in the form of dusts, fumes, mists, vapors, or gases;

(3) "Byproduct material" means any radioactive material (except special nuclear material) yielded in or made radioactive by exposure to the radiation incident to the process of producing or utilizing special nuclear material;

40 FR 42557

(4) "Calendar quarter" means not less than 12 consecutive weeks nor more than 14 consecutive weeks. The first calendar quarter of each year shall begin in January and subsequent calendar quarters shall be such that no day is included in more than one calendar quarter or omitted from inclusion within a calendar quarter. No licensee shall change the method observed by him of determining calendar quarters except at the beginning of a calendar year.

(5) "Commission" means the Nuclear Regulatory Commission or its duly authorized representatives;

MSD 000611

(6) "Government agency" means any executive department, commission, independent establishment, corporation, wholly or partly owned by the United States of America which is an instrumentality of the United States, or any board, bureau, division, service, office, officer, authority, administration, or other establishment in the executive branch of the Government;

(7) "Individual" means any human being;

(8) "Licensed material" means source material, special nuclear material, or by-product material received, possessed, used, or transferred under a general or specific license issued by the Commission pursuant to the regulations in this chapter;

(9) "License" means a license issued under the regulations in Part 30, 40, or 70 of this chapter. "Licensee" means the holder of such license;

(10) "Occupational dose" includes exposure of an individual to radiation (i) in a restricted area; or (ii) in the course of employment in which the individual's duties involve exposure to radiation; provided, that "occupational dose" shall not be deemed to include any exposure of an individual to radiation for the purpose of medical diagnosis or medical therapy of such individual.

25 FR 10914

(11) "Person" means (i) any individual, corporation, partnership, firm, association, trust, estate, public or private institution, group, Government agency other than the Commission or the Administration (except that the Administration shall be considered a person within the meaning of the regulations in this part to the extent that its facilities and activities are subject to the licensing and related regulatory authority of the Commission pursuant to section 202 of the Energy Reorganization Act of 1974 (88 Stat. 1244)), any State, any foreign government or nation or any political subdivision of any such government or nation, or other entity; and (ii) any legal successor, representative, agent, or agency of the foregoing.

40 FR 8774

(12) "Radiation" means any or all of the following: alpha rays, beta rays, gamma rays, X-rays, neutrons, high-speed electrons, high-speed protons, and other atomic particles; but not sound or radio waves, or visible, infrared, or ultraviolet light;

(13) "Radioactive material" includes any such material whether or not subject to licensing control by the Commission;

25 FR 10914

(14) "Restricted area" means any area access to which is controlled by the licensee for purposes of protection of individuals from exposure to radiation and radioactive materials. "Restricted area" shall not include any areas used as residential quarters, although a separate room or rooms in a residential building may be set apart as a restricted area;

25 FR 13952

(15) "Source material" means (i) uranium or thorium, or any combination thereof, in any physical or chemical form; or (ii) ores which contain by weight one-twentieth of one percent (0.05%) or more of a. uranium, b. thorium or c. any combination thereof. Source material does not include special nuclear material.

27 FR 5905

(16) "Special nuclear material" means (i) plutonium, uranium 233, uranium enriched in the isotope 233 or in the isotope 235, and any other material which the Commission, pursuant to the provisions of section 51 of the act, determines to be special nuclear material, but does not include source material; or (ii) any material artificially enriched by any of the foregoing but does not include source material;

25 FR 10914

(17) "Unrestricted area" means any area access to which is not controlled by the licensee for purposes of protection of individuals from exposure to radiation and radioactive materials, and any area used for residential quarters.

25 FR 13952

(18) "Administration" means the Energy Research and Development Administration or its duly authorized representatives.

40 FR 8774

(b) Definitions of certain other words and phrases as used in this part are set forth in other sections, including:

(1) "Airborne radioactivity area" defined in § 20.203;

(2) "Radiation area" and "high radiation area" defined in § 20.202;

(3) "Personnel monitoring equipment" defined in § 20.202;

(4) "Survey" defined in § 20.201;

(5) Units of measurement of dose (rad, rem) defined in § 20.4;

(6) Units of measurement of radioactivity defined in § 20.5.

§ 20.4 Units of radiation dose.

(a) "Dose," as used in this part, is the quantity of radiation absorbed, per unit of mass, by the body or by any portion of the body. When the regulations in this part specify a dose during a period of time, the dose means the total quantity of radiation absorbed, per unit of mass, by the body or by any portion of the body during such period of time. Several different units of dose are in current use. Definitions of units as used in this part are set forth in paragraphs (b) and (c) of this section.

(b) The rad, as used in this part, is a measure of the dose of any ionizing radiation to body tissues in terms of the energy absorbed per unit mass of the tissue. One rad is the dose corresponding to the absorption of 100 ergs per gram of tissue. (One millirad (mrad) = 0.001 rad.)

(c) The rem, as used in this part, is a measure of the dose of any ionizing radiation to body tissue in terms of its estimated biological effect relative to a dose of one roentgen (r) of X-rays. (One millirem (mrem) = 0.001 rem.) The relation of the rem to other dose units depends upon the biological effect under consideration and upon the conditions of irradiation. For the purpose of the regulations in this part, any of the following is considered to be equivalent to a dose of one rem:

(1) A dose of 1 r due to X— or gamma radiation;

(2) A dose of 1 rad due to X—, gamma, or beta radiation;

(3) A dose of 0.1 rad due to neutrons or high energy protons;

(4) A dose of 0.05 rad due to particles heavier than protons and with sufficient energy to reach the lens of the eye;

If it is more convenient to measure the neutron flux, or equivalent, than to determine the neutron dose in rads, as provided in subparagraph (3) of this paragraph, one rem of neutron radiation may, for purposes of the regulations in this part, be assumed to be equivalent to 14 million neutrons per square centimeter incident upon the body; or, if there exists sufficient information to estimate with reasonable accuracy the approximate distribution in energy of the neutrons, the incident number of neutrons per square centimeter equivalent to one rem may be estimated from the following table:

NEUTRON FLUX DOSE EQUIVALENTS

Neutron energy (Mev)	Number of neutrons per square centimeter equivalent to a dose of 1 rem (neutrons/cm²)	Average flux to deliver 100 millirem in 40 hours (neutrons/cm² per sec.)
Thermal	970×10^6	670
0.0001	720×10^6	500
0.005	830×10^6	570
0.02	400×10^6	280
0.1	120×10^6	80
0.5	43×10^6	30
1.0	26×10^6	18
2.5	29×10^6	20
5.0	26×10^6	18
7.5	24×10^6	17
10	24×10^6	17
10 to 30	14×10^6	10

25 FR 10914

(d) For determining exposures to X or gamma rays up to 3 Mev, the dose limits specified in §§ 20.101 to 20.104, inclusive, may be assumed to be equivalent to the "air dose". For the purpose of this part "air dose" means that the dose is measured by a properly calibrated appropriate instrument in air at or near the body surface in the region of highest dosage rate.

§ 20.5 Units of radioactivity.

(a) Radioactivity is commonly, and for purposes of the regulations in this part shall be, measured in terms of disintegrations per unit time or in curies. One curie = 3.7×10^{10} disintegrations per second (dps) = 2.2×10^{12} disintegrations per minute (dpm). Commonly used submultiples of the curie are the millicurie and the microcurie:

(1) One millicurie (mCi) [1] = 0.001 curie (Ci) [1] = 3.7×10^7 dps.

(2) One microcurie (μCi) [1] = 0.000001 curie = 3.7×10^4 dps.

38 FR 29314

[1] Wherever possible, the appropriate unit should be written out as "curie(s)," "millicurie(s)," or "microcurie(s)," and the abbreviations should not be used.

(b) [Deleted 40 FR 50704.]

(c) [Deleted 39 FR 23990.]

25 FR 10914

§ 20.6 **Interpretations.**

Except as specifically authorized by the Commission in writing, no interpretation of the meaning of the regulations in this part by any officer or employee of the Commission other than a written interpretation by the General Counsel will be recognized to be binding upon the Commission.

40 FR 8774

§ 20.7 **Communications.**

Except where otherwise specified in this part, all communications and reports concerning the regulations in this part should be addressed to the Executive Director for Operations, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555. Communications, reports, and applications may be delivered in person at the Commission's offices at 1717 H Street NW., Washington, D.C.; or at 7920 Norfolk Avenue, Bethesda, Maryland.

25 FR 10914

** PERMISSIBLE DOSES, LEVELS, AND CONCENTRATIONS

§ 20.101 **Exposure of individuals to radiation in restricted areas.**

(a) Except as provided in paragraph (b) of this section, no licensee shall possess, use, or transfer licensed material in such a manner as to cause any individual in a restricted area to receive in any period of one calendar quarter from radioactive material and other sources of radiation in the licensee's possession a dose in excess of the limits specified in the following table:

Rems per calendar quarter	
1. Whole body; head and trunk; active blood-forming organs; lens of eyes; or gonads	1¼
2. Hands and forearms; feet and ankles	18¾
3. Skin of whole body	7½

(b) A licensee may permit an individual in a restricted area to receive a dose to the whole body greater than that permitted under paragraph (a) of this section, provided:

(1) During any calendar quarter the dose to the whole body from radioactive material and other sources of radiation in the licensee's possession shall not exceed 3 rems; and

(2) The dose to the whole body, when added to the accumulated occupational dose to the whole body, shall not exceed 5 (N–18) rems where "N" equals the individual's age in years at his last birthday; and

(3) The licensee has determined the individual's accumulated occupational dose to the whole body on Form NRC-4, or on a clear and legible record containing all the information required in that form; and has otherwise complied with the requirements of § 20.102. As used in paragraph (b), "Dose to the whole body" shall be deemed to include any dose to the whole body, gonads, active blood-forming organs, head and trunk, or lens of eye.

25 FR 10914

§ 20.102 **Determination of accumulated dose.**

(a) This section contains requirements which must be satisfied by licensees who propose, pursuant to paragraph (b) of § 20.101, to permit individuals in a restricted area to receive exposure to radiation in excess of the limits specified in paragraph (a) of § 20.101.

(b) Before permitting any individual in a restricted area to receive exposure to radiation in excess of the limits specified in paragraph (a) of § 20.101, each licensee shall:

(1) Obtain a certificate on Form NRC-4, or on a clear and legible record containing all the information required in that form, signed by the individual showing each period of time after the individual attained the age of 18 in which the individual received an occupational dose of radiation; and

(2) Calculate on Form NRC-4 in accordance with the instructions appearing therein, or on a clear and legible record containing all the information required in that form, the previously accumulated occupational dose received by the individual and the additional dose allowed for that individual under § 20.101(b).

(c)(1) In the preparation of Form NRC-4, or a clear and legible record containing all the information required in that form, the licensee shall make a reasonable effort to obtain reports of the individual's previously accumulated occupational dose. For each period for which the licensee obtains such reports, the licensee shall use the dose shown in the report in preparing the form. In any case where a licensee is unable to obtain reports of the individual's occupational dose for a previous complete calendar quarter, it shall be assumed that the individual has received the occupational dose specified in whichever of the following columns apply:

Part of body	Column 1 Assumed exposure in rems for calendar quarters prior to Jan. 1, 1961	Column 2 Assumed exposure in rems for calendar quarters beginning on or after Jan. 1, 1961
Whole body, gonads, active blood-forming organs, head and trunk, lens of eye.	3¾	1¼

(2) The licensee shall retain and preserve records used in preparing Form NRC-4. If calculation of the individual's accumulated occupational dose for all periods prior to January 1, 1961 yields a result higher than the applicable accumulated dose value for the individual as of that date, as specified in paragraph (b) of § 20.101, the excess may be disregarded.

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§ 20.103 **Exposure of individuals to concentrations of radioactive material in restricted areas.**

(a) No licensee shall possess, use or transfer licensed material in such a manner as to cause any individual in a restricted area to be exposed to airborne radioactive material possessed by the licensee in an average concentration in excess of the limits specified in Appendix B, Table I, of this part. "Expose" as used in this section means that the individual is present in an airborne concentration. No allowance shall be made for the use of protective clothing or equipment, or particle size, except as authorized by the Commission pursuant to paragraph (c) of this section.

(b) The limits given in Appendix B, Table I, of this part are based upon exposure to the concentrations specified for forty hours in any period of seven consecutive days. In any such period where the number of hours of exposure is less than forty, the limits specified in the table may be increased proportionately. In any such period where the number of hours of exposure is greater than forty, the limits specified in the table shall be decreased proportionately.

(c)(1) Except as authorized by the Commission pursuant to this paragraph, no allowance shall be made for particle size or the use of protective clothing or equipment in determining whether an individual is exposed to an airborne concentration in excess of the limits specified in Appendix B, Table I.

(2) The Commission may authorize a licensee to expose an individual in a restricted area to airborne concentrations in excess of the limits specified in Appendix B, Table I, upon receipt of an application demonstrating that the concentration is composed in whole or in part of particles of such size that such particles are not respirable; and that the individual will not inhale the concentrations in excess of the limits established in Appendix B, Table I. Each application under this subparagraph shall include an analysis of particle sizes in the concentrations; and a description

[5] The duration of sample collection and the duration of measurement should be sufficiently short compared to the time between collection and measurement, as not to have a statistically significant effect upon the results.

** Amended 36 FR 1466.

NOTE: Amendments made by 40 FR 50704 become effective 1/29/76.

of the methods used in determining the particle sizes.

(3) The Commission may authorize a licensee to expose an individual in a restricted area to airborne concentrations in excess of the limits specified in Appendix B, Table I, upon receipt of an application demonstrating that the individual will wear appropriate protective equipment and that the individual will not inhale, ingest or absorb quantities of radioactive material in excess of those which might otherwise be permitted under this part for employees in restricted areas during a 40-hour week. Each application under this subparagraph shall contain the following information:

(i) A description of the protective equipment to be employed, including the efficiency of the equipment for the material involved;

(ii) Procedures for the fitting, maintenance and cleaning of the protective equipment; and

(iii) Procedures governing the use of the protective equipment, including supervisory procedures and length of time the equipment will be used by the individuals in each work week. The proposed periods for use of the equipment by any individual should not be of such duration as would discourage observance by the individual of the proposed procedures; and

(iv) The average concentrations present in the areas occupied by employees.

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§ 20.104 Exposure of minors.

(a) No licensee shall possess, use or transfer licensed material in such a manner as to cause any individual within a restricted area who is under 18 years of age, to receive in any period of one calendar quarter from radioactive material and other sources of radiation in the licensee's possession a dose in excess of 10 percent of the limits specified in the table in paragraph (a) of § 20.101.

(b) No licensee shall possess, use or transfer licensed material in such a manner as to cause any individual within a restricted area, who is under 18 years of age to be exposed to airborne radioactive material possessed by the licensee in an average concentration in excess of the limits specified in Appendix B, Table II of this part. For purposes of this paragraph, concentrations may be averaged over periods not greater than a week.

29 FR 14434

(c) The provisions of paragraph (c) of § 20.103, shall apply to exposures subject to paragraph (b) of this section.

§ 20.105 Permissible levels of radiation in unrestricted areas.

(a) There may be included in any application for a license or for amendment of a license proposed limits upon levels of radiation in unrestricted areas resulting from the applicant's possession or use of radioactive material and other sources of radiation. Such applications should include information as to anticipated average radiation levels and anticipated occupancy times for each unrestricted area involved. The Commission will approve the proposed limits if the applicant demonstrates that the proposed limits are not likely to cause any individual to receive a dose to the whole body in any period of one calendar year in excess of 0.5 rem.

(b) Except as authorized by the Commission pursuant to paragraph (a) of this section, no licensee shall possess, use or transfer licensed material in such a manner as to create in any unrestricted area from radioactive material and other sources of radiation in his possession:

(1) Radiation levels which, if an individual were continuously present in the area, could result in his receiving a dose in excess of two millirems in any one hour, or

(2) Radiation levels which, if an individual were continuously present in the area, could result in his receiving a dose in excess of 100 millirems in any seven consecutive days.

25 FR 10914

§ 20.106 Radioactivity in effluents to unrestricted areas.

(a) A licensee shall not possess, use, or transfer licensed material so as to release to an unrestricted area radioactive material in concentrations which exceed the limits specified in Appendix "B", Table II of this part, except as authorized pursuant to § 20.302 or paragraph (b) of this section. For purposes of this section concentrations may be averaged over a period not greater than one year.

(b) An application for a license or amendment may include proposed limits higher than those specified in paragraph (a) of this section. The Commission will approve the proposed limits if the applicant demonstrates:

(1) That the applicant has made a reasonable effort to minimize the radioactivity contained in effluents to unrestricted areas; and

(2) That it is not likely that radioactive material discharged in the effluent would result in the exposure of an individual to concentrations of radioactive material in air or water exceeding the limits specified in Appendix "B", Table II of this part.

(c) An application for higher limits pursuant to paragraph (b) of this section shall include information demonstrating that the applicant has made a reasonable effort to minimize the radioactivity discharged in effluents to unrestricted areas, and shall include, as pertinent:

(1) Information as to flow rates, total volume of effluent, peak concentration of each radionuclide in the effluent, and concentration of each radionuclide in the effluent averaged over a period of one year at the point where the effluent leaves a stack, tube, pipe, or similar conduit;

(2) A description of the properties of the effluents, including:

(i) chemical composition;

(ii) physical characteristics, including suspended solids content in liquid effluents, and nature of gas or aerosol for air effluents;

(iii) the hydrogen ion concentrations (p^H) of liquid effluents; and

(iv) the size range of particulates in effluents released into air.

(3) A description of the anticipated human occupancy in the unrestricted area where the highest concentration of radioactive material from the effluent is expected, and, in the case of a river or stream, a description of water uses downstream from the point of release of the effluent.

(4) Information as to the highest concentration of each radionuclide in an unrestricted area, including anticipated concentrations averaged over a period of one year:

(i) In air at any point of human occupancy; or

(ii) In water at points of use downstream from the point of release of the effluent.

(5) The background concentration of radionuclides in the receiving river or stream prior to the release of liquid effluent.

(6) A description of the environmental monitoring equipment, including sensitivity of the system, and procedures and calculations to determine concentrations of radionuclides in the unrestricted area and possible reconcentrations of radionuclides.

(7) A description of the waste treatment facilities and procedures used to reduce the concentration of radionuclides in effluents prior to their release.

(d) For the purposes of this section the concentration limits in Appendix "B", Table II of this part shall apply at the boundary of the restricted area. The concentration of radioactive material discharged through a stack, pipe or similar conduit may be determined with respect to the point where the material leaves the conduit. If the conduit discharges within the restricted area, the concentration at the boundary may be determined by applying appropriate factors for dilution, dispersion, or decay between the point of discharge and the boundary.

(e) In addition to limiting concentrations in effluent streams, the Commission may limit quantities of radioactive materials released in air or water during a specified period of time if it appears that the daily intake of radioactive material from air, water, or food by a suitable sample of an exposed population group, averaged over a period not exceeding one year, would otherwise exceed the daily intake resulting from continuous exposure to air or water containing one-third the concentration of radioactive materials specified in Appendix "B", Table II of this part.

(f) The provisions of this section do not apply to disposal of radioactive material into sanitary sewerage systems, which is governed by § 20.303

29 FR 14434

§ 20.107 Medical diagnosis and therapy.

Nothing in the regulations in this part shall be interpreted as limiting the intentional exposure of patients to radiation for the purpose of medical diagnosis or medical therapy.

§ 20.108 Orders requiring furnishing of bio-assay services.

Where necessary or desirable in order to aid in determining the extent of an

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individual's exposure to concentrations of radioactive material, the Commission may incorporate appropriate provisions in any license, directing the licensee to make available to the individual appropriate bio-assay services and to furnish a copy of the reports of such services to the Commission.

PRECAUTIONARY PROCEDURES

§ 20.201 Surveys.

(a) As used in the regulations in this part, "survey" means an evaluation of the radiation hazards incident to the production, use, release, disposal, or presence of radioactive materials or other sources of radiation under a specific set of conditions. When appropriate, such evaluation includes a physical survey of the location of materials and equipment, and measurements of levels of radiation or concentrations of radioactive material present.

(b) Each licensee shall make or cause to be made such surveys as may be necessary for him to comply with the regulations in this part.

§ 20.202 Personnel monitoring.

(a) Each licensee shall supply appropriate personnel monitoring equipment to, and shall require the use of such equipment by:

(1) Each individual who enters a restricted area under such circumstances that he receives, or is likely to receive, a dose in any calendar quarter in excess of 25 percent of the applicable value specified in paragraph (a) of § 20.101.

(2) Each individual under 18 years of age who enters a restricted area under such circumstances that he receives, or is likely to receive, a dose in any calendar quarter in excess of 5 percent of the applicable value specified in paragraph (a) of § 20.101.

(3) Each individual who enters a high radiation area.

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(b) As used in this part,

(1) "Personnel monitoring equipment" means devices designed to be worn or carried by an individual for the purpose of measuring the dose received (e. g., film badges, pocket chambers, pocket dosimeters, film rings, etc.);

(2) "Radiation area" means any area, accessible to personnel, in which there exists radiation, originating in whole or in part within licensed material, at such levels that a major portion of the body could receive in any one hour a dose in excess of 5 millirem, or in any 5 consecutive days a dose in excess of 100 millirems;

(3) "High radiation area" means any area, accessible to personnel, in which there exists radiation originating in whole or in part within licensed material at such levels that a major portion of the body could receive in any one hour a dose in excess of 100 millirem.

35 FR 5033

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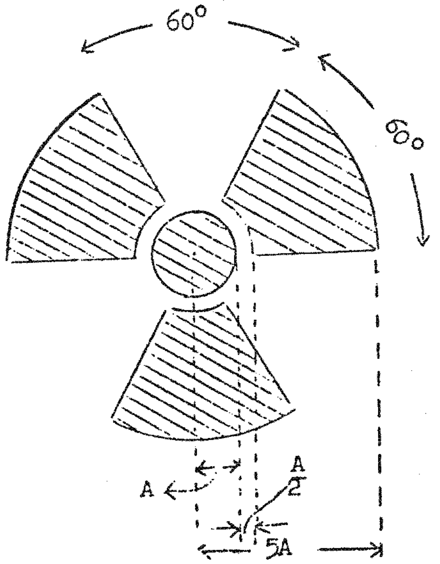
§ 20.203 Caution signs, labels, signals, and controls.

(a) *General.* (1) Except as otherwise authorized by the Commission, symbols prescribed by this section shall use the conventional radiation caution colors (magenta or purple on yellow background). The symbol prescribed by this section is the conventional three-bladed design:

RADIATION SYMBOL

1. Cross-hatched area is to be magenta or purple.
2. Background is to be yellow.



(2) In addition to the contents of signs and labels prescribed in this section, licensees may provide on or near such signs and labels any additional information which may be appropriate in aiding individuals to minimize exposure to radiation or to radioactive material.

(b) *Radiation areas.* Each radiation area shall be conspicuously posted with a sign or signs bearing the radiation caution symbol and the words:

CAUTION [1]
RADIATION AREA

(c) *High radiation areas.* (1) Each high radiation area shall be conspicuously posted with a sign or signs bearing the radiation caution symbol and the words:

CAUTION [1]
HIGH RADIATION AREA

(2) Each entrance or access point to a high radiation area shall be:

(i) Equipped with a control device which shall cause the level of radiation to be reduced below that at which an individual might receive a dose of 100 millirems in 1 hour upon entry into the area; or

(ii) Equipped with a control device which shall energize a conspicuous visible or audible alarm signal in such a manner that the individual entering the high radiation area and the licensee or a supervisor of the activity are made aware of the entry; or

(iii) Maintained locked except during periods when access to the area is required, with positive control over each individual entry.

35 FR 5033

(3) The controls required by subparagraph (2) of this paragraph shall be established in such a way that no individual will be prevented from leaving a high radiation area.

(4) In the case of a high radiation area established for a period of 30 days or less, direct surveillance to prevent unauthorized entry may be substituted for the controls required by subparagraph (2) of this paragraph.

(5) Any licensee, or applicant for a license, may apply to the Commission for approval of methods not included in subparagraphs (2) and (4) of this paragraph for controlling access to high radiation areas. The Commission will approve the proposed alternatives if the licensee or applicant demonstrates that the alternative methods of control will prevent unauthorized entry into a high radiation area, and that the requirement of subparagraph (3) of this paragraph is met.

35 FR 5033

(d) *Airborne radioactivity areas.* (1) As used in the regulations in this part, "airborne radioactivity area" means (i) any room, enclosure, or operating area in which airborne radioactive materials, composed wholly or partly of licensed material, exist in concentrations in excess of the amounts specified in Appendix B, Table I, Column 1 of this part; or (ii) any room, enclosure, or operating area in which airborne radioactive material composed wholly or partly of licensed material exists in concentrations which, averaged over the number of hours in any week during which individuals are in the area, exceed 25 percent of the amounts specified in Appendix B, Table I, Column 1 of this part.

(2) Each airborne radioactivity area shall be conspicuously posted with a sign or signs bearing the radiation caution symbol and the words:

CAUTION [1]
AIRBORNE RADIOACTIVITY AREA

(e) *Additional requirements.* (1) Each area or room in which licensed material is used or stored and which contains any radioactive material (other than natural uranium or thorium) in an amount exceeding 10 times the quantity of such material specified in Appendix C of this part shall be conspicuously posted with a sign or signs bearing the radiation caution symbol and the words:

CAUTION [1]
RADIOACTIVE MATERIAL(S)

(2) Each area or room in which natural uranium or thorium is used or stored in an amount exceeding one-hundred times the quantity specified in Appendix C of this part shall be conspicuously posted with a sign or signs bearing the radiation caution symbol and the words:

CAUTION [1]
RADIOACTIVE MATERIAL(S)

(f) *Containers.* (1) Except as provided in subparagraph (3) of this paragraph, each container of licensed mate-

[1] Or "Danger."

31 FR 10514

rial shall bear a durable, clearly visible label identifying the radioactive contents.

(2) A label required pursuant to subparagraph (1) of this paragraph shall bear the radiation caution symbol and the words "CAUTION, RADIOACTIVE MATERIAL" or "DANGER, RADIOACTIVE MATERIAL". It shall also provide sufficient information[1] to permit individuals handling or using the containers, or working in the vicinity thereof, to take precautions to avoid or minimize exposures.

(3) Notwithstanding the provisions of subparagraph (1) of this paragraph, labeling is not required:

(i) For containers that do not contain licensed materials in quantities greater than the applicable quantities listed in Appendix C of this part.

(ii) For containers containing only natural uranium or thorium in quantities no greater than 10 times the applicable quantities listed in Appendix C of this part.

(iii) For containers that do not contain licensed materials in concentrations greater than the applicable concentrations listed in Column 2, Table I, Appendix B of this part.

(iv) For containers when they are attended by an individual who takes the precautions necessary to prevent the exposure of any individual to radiation or radioactive materials in excess of the limits established by the regulations in this part.

(v) For containers when they are in transport and packaged and labeled in accordance with regulations of the * Department of Transportation.

(vi) For containers which are accessible[2] only to individuals authorized to handle or use them, or to work in the vicinity thereof, provided that the contents are identified to such individuals by a readily available written record.

(vii) For manufacturing or process equipment, such as nuclear reactors, reactor components, piping, and tanks.

25 FR 10914

§ 20.204 Same: exceptions.

Notwithstanding the provisions of § 20.203,

(a) A room or area is not required to be posted with a caution sign because of the presence of a sealed source provided the radiation level twelve inches from the surface of the source container or housing does not exceed five millirem per hour.

(b) Rooms or other areas in hospitals are not required to be posted with caution signs, and control of entrance or access thereto pursuant to § 20.203(c) is not required, because of the presence of

35 FR 5033

patients containing byproduct material provided that there are personnel in attendance who will take the precautions necessary to prevent the exposure of any individual to radiation or radioactive material in excess of the limits established in the regulations in this part.

25 FR 10914

(c) Caution signs are not required to be posted at areas or rooms containing radioactive materials for periods of less than eight hours provided that (1) the materials are constantly attended during such periods by an individual who shall take the precautions necessary to prevent the exposure of any individual to radiation or radioactive materials in excess of the limits established in the regulations in this part and; (2) such area or room is subject to the licensee's control.

35 FR 5033

(d) A room or other area is not required to be posted with a caution sign, and control is not required for each entrance or access point to a room or other area which is a high radiation area solely because of the presence of radioactive materials prepared for transport and packaged and labeled in accordance with regulations of the Department of Transportation.

39 FR 17972

§ 20.205 Procedures for picking up, receiving, and opening packages.

(a) (1) Each licensee who expects to receive a package containing quantities of radioactive material in excess of the Type A quantities specified in paragraph (b) of this section shall:

(i) If the package is to be delivered to the licensee's facility by the carrier, make arrangements to receive the package when it is offered for delivery by the carrier; or

(ii) If the package is to be picked up by the licensee at the carrier's terminal, make arrangements to receive notification from the carrier of the arrival of the package, at the time of arrival.

(2) Each licensee who picks up a package of radioactive material from a carrier's terminal shall pick up the package expeditiously upon receipt of notification from the carrier of its arrival.

(b) (1) Each licensee, upon receipt of a package of radioactive material, shall monitor the external surfaces of the package for radioactive contamination caused by leakage of the radioactive contents, except:

(i) Packages containing no more than the exempt quantity specified in the table in this paragraph;

(ii) Packages containing no more than 10 millicuries of radioactive material consisting solely of tritium, carbon-14, sulfur-35, or iodine-125;

(iii) Packages containing only radioactive material as gases or in special form;

(iv) Packages containing only radioactive material in other than liquid form (including Mo-99/Tc-99m generators) and not exceeding the Type A quantity limit specified in the table in this paragraph; and

(v) Packages containing only radionuclides with half-lives of less than 30 days and a total quantity of no more than 100 millicuries.

The monitoring shall be performed as soon as practicable after receipt, but no later than three hours after the package is received at the licensee's facility if received during the licensee's normal working hours, or eighteen hours if received after normal working hours.

(2) If removable radioactive contamination in excess of 0.01 microcuries (22,000 disintegrations per minute) per 100 square centimeters of package surface is found on the external surfaces of the package, the licensee shall immediately notify the final delivering carrier and, by telephone and telegraph, the appropriate Nuclear Regulatory Commission Inspection and Enforcement Regional Office shown in Appendix D.

TABLE OF EXEMPT AND TYPE A QUANTITIES

Transport group[1]	Exempt quantity limit (in millicuries)	Type A quantity limit (in curies)
I	.01	0.001
II	0.1	0.050
III	1	3
IV	1	20
V	1	20
VI	1	1000
VII	25,000	1000
Special Form	1	20

(c) (1) Each licensee, upon receipt of a package containing quantities of radioactive material in excess of the Type A quantities specified in paragraph (b) of this section, other than those transported by exclusive use vehicle, shall monitor the radiation levels external to the package. The package shall be monitored as soon as practicable after receipt, but no later than three hours after the package is received at the licensee's facility if received during the licensee's normal working hours, or 18 hours if received after normal working hours.

(2) If radiation levels are found on the external surface of the package in excess of 200 millirem per hour, or at three feet from the external surface of the package in excess of 10 millirem per hour, the licensee shall immediately notify, by telephone and telegraph, the final delivering carrier and the appropriate Nuclear Regulatory Commission Inspection and Enforcement Regional Office shown in Appendix D.

(d) Each licensee shall establish and maintain procedures for safely opening packages in which licensed material is received, and shall assure that such procedures are followed and that due consideration is given to special instructions for the type of package being opened.

38 FR 22220

§ 20.206 Instruction of personnel.

Instructions required for individuals working in or frequenting any portion of a restricted area are specified in § 19.12 of this chapter.

[1] As appropriate, the information will include radiation levels, kinds of material, estimate of activity, date for which activity is estimated, mass enrichment, etc.

[2] For example, containers in locations such as water-filled canals, storage vaults, or hot cells.

* Amended 34 FR 19546.

[1] The definitions of "transport group" and "special form" are specified in § 71.4 of this chapter.

40 FR 26679

§ 20.207 **Storage and control of licensed materials in unrestricted areas.**

(a) Licensed materials stored in an unrestricted area shall be secured from unauthorized removal from the place of storage.

(b) Licensed materials in an unrestricted area and not in storage shall be tended under the constant surveillance and immediate control of the licensee.

WASTE DISPOSAL

25 FR 10914

§ 20.301 **General requirement.**

No licensee shall dispose of licensed material except:

(a) By transfer to an authorized recipient as provided in the regulations in Part 30, 40, or 70 of this chapter, whichever may be applicable; or

(b) As authorized pursuant to § 20.302; or

(c) As provided in § 20.303 or § 20.304, applicable respectively to the disposal of licensed material by release into sanitary sewerage systems or burial in soil, or in § 20.106 (Radioactivity in Effluents to Unrestricted Areas).

§ 20.302 **Method for obtaining approval of proposed disposal procedures.**

*(a) Any licensee or applicant for a license may apply to the Commission for approval of proposed procedures to dispose of licensed material in a manner not otherwise authorized in the regulations in this chapter. Each application should include a description of the licensed material and any other radioactive material involved, including the quantities and kinds of such material and the levels of radioactivity involved, and the proposed manner and conditions of disposal. The application should also include an analysis and evaluation of pertinent information as to the nature of the environment, including topographical, geological, meteorological, and hydrological characteristics; usage of ground and surface waters in the general area; the nature and location of other potentially affected facilities; and procedures to be observed to minimize the risk of unexpected or hazardous exposures.

26 FR 352

*(b) The Commission will not approve any application for a license to receive licensed material from other persons for disposal on land not owned by the Federal government or by a State government.

36 FR 23138

(c) The Commission will not approve any application for a license for disposal of licensed material at sea unless the applicant shows that sea disposal offers less harm to man or the environment than other practical alternative methods of disposal.

25 FR 10914

§ 20.303 **Disposal by release into sanitary sewerage systems.**

No licensee shall discharge licensed material into a sanitary sewerage system unless:

(a) It is readily soluble or dispersible in water; and

(b) The quantity of any licensed or other radioactive material released into the system by the licensee in any one day does not exceed the larger of subparagraphs (1) or (2) of this paragraph:

(1) The quantity which, if diluted by the average daily quantity of sewage released into the sewer by the licensee, will result in an average concentration equal to the limits specified in Appendix B, Table I, Column 2 of this part; or

(2) Ten times the quantity of such material specified in Appendix C of this part; and

(c) The quantity of any licensed or other radioactive material released in any one month, if diluted by the average monthly quantity of water released by the licensee, will not result in an average concentration exceeding the limits specified in Appendix B, Table I, Column 2 of this part; and

(d) The gross quantity of licensed and other radioactive material released into the sewerage system by the licensee does not exceed one curie per year.

Excreta from individuals undergoing medical diagnosis or therapy with radioactive material shall be exempt from any limitations contained in this section.

25 FR 10914

§ 20.304 **Disposal by burial in soil.**

No licensee shall dispose of licensed material by burial in soil unless:

(a) The total quantity of licensed and other radioactive materials buried at any one location and time does not exceed, at the time of burial, 1,000 times the amount specified in Appendix C of this part; and

(b) Burial is at a minimum depth of four feet; and

(c) Successive burials are separated by distances of at least six feet and not more than 12 burials are made in any year.

§ 20.305 **Treatment or disposal by incineration.**

No licensee shall treat or dispose of licensed material by incineration except as specifically approved by the Commission pursuant to §§ 20.106(b) and 20.302.

RECORDS, REPORTS, AND NOTIFICATION

§ 20.401 **Records of surveys, radiation monitoring, and disposal.**

(a) Each licensee shall maintain records showing the radiation exposures of all individuals for whom personnel monitoring is required under § 20.202 of the regulations in this part. Such records shall be kept on Form NRC-5, in accordance with the instructions contained in that form or on clear and legible records containing all the information required by Form NRC-5. The doses entered on the forms or records shall be for periods of time not exceeding one calendar quarter.

39 FR 17972

(b) Each licensee shall maintain records in the same units used in this part, showing the results of surveys required by § 20.201(b), monitoring required by §§ 20.205(b) and 20.205(c), and disposals made under §§ 20.302, 20.303, and 20.304.

35 FR 1810

(c) Records of individual exposure to radiation and to radioactive material which must be maintained pursuant to the provisions of paragraph (a) of this section and records of bio-assays, including results of whole body counting examinations, made pursuant to § 20.108 shall be preserved indefinitely or until the Commission authorizes their disposal. Records which must be maintained pursuant to this part may be maintained in the form of microfilms.

34 FR 7500

§ 20.402 **Reports of theft or loss of licensed material.**

(a) Each licensee shall report by telephone and telegraph to the Director of the appropriate Nuclear Regulatory Commission Inspection and Enforcement Regional Office listed in Appendix D, immediately after its occurrence becomes known to the licensee, any loss or theft of licensed material in such quantities and under such circumstances that it appears to the licensee that a substantial hazard may result to persons in unrestricted areas.

(b) Each licensee who is required to make a telephonic and telegraphic report pursuant to paragraph (a) of this section shall, within 30 days after he learns of the loss or theft, make a report in writing to the Director of Inspection and Enforcement, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, with a copy to the Director of the appropriate Nuclear Regulatory Commission Inspection and Enforcement Regional Office listed in Appendix D, setting forth the following information:

(1) A description of the licensed material involved, including kind, quantity, chemical, and physical form;

(2) A description of the circumstances under which the loss or theft occurred;

(3) A statement of disposition or probable disposition of the licensed material involved;

(4) Radiation exposures to individuals, circumstances under which the exposures occurred, and the extent of possible hazard to persons in unrestricted areas;

(5) Actions which have been taken, or will be taken, to recover the material; and

(6) Procedures or measures which have been or will be adopted to prevent a recurrence of the loss or theft of licensed material.

(c) Subsequent to filing the written report the licensee shall also report any substantive additional information on the loss or theft which becomes available to the licensee, within 30 days after he learns of such information.

(d) Any report filed with the Commission pursuant to this section shall be so prepared that names of individuals who may have received exposure to radiation are stated in a separate part of the report.

27 FR 5905

§ 20.403 **Notifications of incidents.**

(a) *Immediate notification.* Each licensee shall immediately notify the Director of the appropriate Nuclear Regulatory Commission Inspection and Enforcement Regional Office

*Redesignated 36 FR 23138.

MSD 000617

shown in Appendix D by telephone and telegraph of any incident involving byproduct, source or special nuclear material possessed by him and which may have caused or threatens to cause:

(1) Exposure of the whole body of any individual to 25 rems or more of radiation; exposure of the skin of the whole body of any individual of 150 rems or more of radiation; or exposure of the feet, ankles, hands or forearms of any individual to 375 rems or more of radiation; or

(2) The release of radioactive material in concentrations which, if averaged over a period of 24 hours, would exceed 5,000 times the limits specified for such materials in Appendix B, Table II; or

(3) A loss of one working week or more of the operation of any facilities affected; or

(4) Damage to property in excess of $100,000.

(b) *Twenty-four hour notification.* Each licensee shall within 24 hours notify the Director of the appropriate Nuclear Regulatory Commission Inspection and Enforcement Regional Office listed in Appendix D by telephone and telegraph of any incident involving licensed material possessed by him and which may have caused or threatens to cause:

(1) Exposure of the whole body of any individual to 5 rems or more of radiation; exposure of the skin of the whole body of any individual to 30 rems or more of radiation; or exposure of the feet, ankles, hands, or forearms to 75 rems or more of radiation; or

(2) The release of radioactive material in concentrations which, if averaged over a period of 24 hours, would exceed 500 times the limits specified for such materials in Appendix B, Table II; or

(3) A loss of one day or more of the operation of any facilities affected; or

(4) Damage to property in excess of $1,000.

27 FR 5905

(c) Any report filed with the Commission pursuant to this section shall be prepared so that names of individuals who have received exposure to radiation will be stated in a separate part of the report.

28 FR 6822

§ 20.404 [Deleted 38 FR 22220.]

§ 20.405 Reports of overexposures and excessive levels and concentrations.

(a) In addition to any notification required by § 20.403, each licensee shall make a report in writing within 30 days to the Director of Inspection and Enforcement, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, with a copy to the appropriate Nuclear Regulatory Commission Inspection and Enforcement Regional Office listed in Appendix D, of (1) each exposure of an individual to radiation or concentrations of radioactive material in excess of any applicable limit in this part or in the licensee's license; (2) any incident for which notification is required by § 20.403; and (3) levels of radiation or concentrations of radioactive material (not involving excessive exposure of any individual) in an unrestricted area in excess of ten times any applicable limit set forth in this part or in the licensee's license.

27 FR 5905

Each report required under this paragraph shall describe the extent of exposure of persons to radiation or to radioactive material, including estimates of each individual's exposure as required by paragraph (b) of this section; levels of radiation and concentrations of radioactive material involved; the cause of the exposure, levels or concentrations; and corrective steps taken or planned to assure against a recurrence.

(b) Any report filed with the Commission pursuant to this section shall include for each individual exposed the name, social security number, and date of birth; and an estimate of the individual's exposure. The report shall be prepared so that this information is stated in a separate part of the report.

35 FR 15067

(c) [Deleted 38 FR 22220.]

§ 20.406 [Deleted 38 FR 22220.]

§ 20.407 Personnel exposure and monitoring reports.

(a) This section applies to each person licensed by the Commission or the Atomic Energy Commission to:

(1) Operate a nuclear reactor designed to produce electrical or heat energy pursuant to § 50.21(b) or § 50.22 of this chapter or a testing facility as defined in § 50.2(r) of this chapter;

(2) Possess or use byproduct material for purposes of radiography pursuant to Parts 30 and 34 of this chapter;

(3) Possess or use at any one time, for purposes of fuel processing, fabrication, or reprocessing, special nuclear material in a quantity exceeding 5,000 grams of contained uranium-235, uranium-233, or plutonium or any combination thereof pursuant to Part 70 of this chapter; or

(4) Possess or use at any one time, for processing or manufacturing for distribution pursuant to Part 30, 32, or 33 of this chapter, byproduct material in quantities exceeding anyone of the following quantities:

Radionuclide [1]	*Quantity in curies*
Cesium-137	1
Cobalt-60	1
Gold-198	100
Iodine-131	1
Iridium-192	10
Krypton-85	1,000
Promethium-147	10
Technetium-99m	1,000

(b) Each person described in paragraph (a) of this section shall, within the first quarter of each calendar year, submit to the Executive Director for Operations, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, the following reports, applicable to the described licensed activities covering the preceding calendar year: [2]

(1) A report of either (i) the total number of individuals for whom personnel monitoring was required under §§ 20.202(a) or 34.33(a) of this chapter during the calendar year, or (ii) the total number of individuals for whom personnel monitoring was provided during the calendar year; *Provided*, that such total includes at least the number of individuals required to be reported under paragraph (b)(1)(i) of this section. The report shall indicate whether it is submitted in accordance with paragraph (b)(1)(i) or (ii) of this section.

(2) A statistical summary report of the personnel monitoring information recorded by the licensee for individuals for whom personnel monitoring was either required or provided, as described in § 20.407(b)(1), indicating the number of individuals whose total whole body exposure recorded during the previous calendar year was in each of the following estimated exposure ranges:

Estimated Whole Body Exposure Range (Rems) [3]	*Number of individuals in each range*
No measurable exposure	
Measurable exposure less than 0.1	
0.1 to 0.25	
0.25 to 0.5	
0.5 to 0.75	
0.75 to 1	
1 to 2	
2 to 3	
3 to 4	
4 to 5	
5 to 6	
6 to 7	
7 to 8	
8 to 9	
9 to 10	
10 to 11	
11 to 12	
12+	

The low exposure range data are required in order to obtain better information about the exposures actually recorded. This section does not require improved measurements.

39 FR 1000

§ 20.408 Reports of personnel exposure on termination of employment or work.

When an individual terminates employment with a licensee subject to § 20.407, or an individual assigned to work in such a licensee's facility, but not employed by the licensee, completes his work assignment in the licensee's facility, the licensee shall furnish * to the Executive Director for Operations, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, a report of the individual's exposure to radiation and radioactive material, incurred during the

34 FR 5254

[1] The Commission may require, as a license condition, or by rule, regulation or order pursuant to § 20.502, reports from licensees who are licensed to use radionuclides not on this list, in quantities sufficient to cause comparable radiation levels.

[2] A licensee whose license expires or terminates prior to, or on the last day of the calendar year, shall submit reports at the expiration or termination of the license, covering that part of the year during which the license was in effect.

[3] Individual values exactly equal to the values separating Exposure Ranges shall be reported in the higher range.

* Amended 38 FR 22220.

period of employment or work assignment in the licensee's facility, containing information recorded by the licensee pursuant to §§ 20.401(a) and 20.108. Such report shall be furnished within 30 days after the exposure of the individual has been determined by the licensee or 90 days after the date of termination of employment or work assignment, whichever is earlier.

34 FR 5254

§ 20.409 Notifications and reports to individuals.

(a) Requirements for notifications and reports to individuals of exposure to radiation or radioactive material are specified in § 19.13 of this chapter.

(b) When a licensee is required pursuant to §§ 20.405 or 20.408 to report to the Commission any exposure of an individual to radiation or radioactive material, the licensee shall also notify the individual. Such notice shall be transmitted at a time not later than the transmittal to the Commission, and shall comply with the provisions of § 19.13(a) of this chapter.

38 FR 22220

Exceptions and Additional Requirements

§ 20.501 Applications for exemptions.

The Commission may, upon application by any licensee or upon its own initiative, grant such exemptions from the requirements of the regulations in this part as it determines are authorized by law and will not result in undue hazard to life or property.

§ 20.502 Additional requirements.

The Commission may, by rule, regulation, or order, impose upon any licensee such requirements, in addition to those established in the regulations in this part, as it deems appropriate or necessary to protect health or to minimize danger to life or property.

25 FR 10914

§ 20.601 Violations.

An injunction or other court order may be obtained prohibiting any violation of any provision of the Atomic Energy Act of 1954, as amended, or Title II of the Energy Reorganization Act of 1974, or any regulation or order issued thereunder. A court order may be obtained for the payment of a civil penalty imposed pursuant to section 234 of the Act for violation of section 53, 57, 62, 63, 81, 82, 101, 103, 104, 107, or 109 of the Act, or section 206 of the Energy Reorganization Act of 1974, or any rule, regulation, or order issued thereunder, or any term, condition, or limitation of any license issued thereunder, or for any violation for which a license may be revoked under section 186 of the Act. Any person who willfully violates any provision of the Act or any regulation or order issued thereunder may be guilty of a crime and, upon conviction, may be punished by fine or imprisonment or both, as provided by law.

40 FR 8774

APPENDIX A [Reserved]

APPENDIX B

Concentrations in Air and Water Above Natural Background

(See footnotes on page 20-15)

Element (atomic number)	Isotope [1]	†	Table I Column 1 Air (μCi/ml)	Table I Column 2 Water (μCi/ml)	Table II Column 1 Air (μCi/ml)	Table II Column 2 Water (μCi/ml)
Actinium (89)	Ac 227	S	2×10^{-12}	6×10^{-5}	8×10^{-14}	2×10^{-6}
		I	3×10^{-11}	9×10^{-3}	9×10^{-13}	3×10^{-4}
	Ac 228	S	8×10^{-8}	3×10^{-3}	3×10^{-9}	9×10^{-5}
		I	2×10^{-8}	3×10^{-3}	6×10^{-10}	9×10^{-5}
Americium (95)	Am 241	S	6×10^{-12}	1×10^{-4}	2×10^{-13}	4×10^{-6}
		* I	1×10^{-10}	8×10^{-4}	4×10^{-12}	3×10^{-5}
	Am 242m	S	6×10^{-12}	1×10^{-4}	2×10^{-13}	4×10^{-6}
		I	3×10^{-10}	3×10^{-3}	9×10^{-12}	9×10^{-5}
	Am 242	S	4×10^{-8}	4×10^{-3}	1×10^{-9}	1×10^{-4}
		I	5×10^{-8}	4×10^{-3}	2×10^{-9}	1×10^{-4}
	Am 243	S	6×10^{-12}	1×10^{-4}	2×10^{-13}	4×10^{-6}
		I	1×10^{-10}	8×10^{-4}	4×10^{-12}	3×10^{-5}
	Am 244	S	4×10^{-6}	1×10^{-1}	1×10^{-7}	5×10^{-3}
		I	2×10^{-5}	1×10^{-1}	8×10^{-7}	5×10^{-3}
Antimony (51)	Sb 122	S	2×10^{-7}	8×10^{-4}	6×10^{-9}	3×10^{-5}
		I	1×10^{-7}	8×10^{-4}	5×10^{-9}	3×10^{-5}
	Sb 124	S	2×10^{-7}	7×10^{-4}	5×10^{-9}	2×10^{-5}
		I	2×10^{-8}	7×10^{-4}	7×10^{-10}	2×10^{-5}
	Sb 125	S	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	3×10^{-8}	3×10^{-3}	9×10^{-10}	1×10^{-4}
Argon (18)	A 37	Sub[2]	6×10^{-3}	...	1×10^{-4}	...
	A 41	Sub	2×10^{-6}	...	4×10^{-8}	...
Arsenic (33)	As 73	S	2×10^{-6}	1×10^{-2}	7×10^{-8}	5×10^{-4}
		I	4×10^{-7}	1×10^{-2}	1×10^{-8}	5×10^{-4}
	As 74	S	3×10^{-7}	2×10^{-3}	1×10^{-8}	5×10^{-5}
		I	1×10^{-7}	2×10^{-3}	4×10^{-9}	5×10^{-5}
	As 76	S	1×10^{-7}	6×10^{-4}	4×10^{-9}	2×10^{-5}
		I	1×10^{-7}	6×10^{-4}	3×10^{-9}	2×10^{-5}
	As 77	S	5×10^{-7}	2×10^{-3}	2×10^{-8}	8×10^{-5}
		I	4×10^{-7}	2×10^{-3}	1×10^{-8}	8×10^{-5}
Astatine (85)	At 211	S	7×10^{-9}	5×10^{-5}	2×10^{-10}	2×10^{-6}
		I	3×10^{-8}	2×10^{-3}	1×10^{-9}	7×10^{-5}
Barium (56)	Ba 131	S	1×10^{-6}	5×10^{-3}	4×10^{-8}	2×10^{-4}
		I	4×10^{-7}	5×10^{-3}	1×10^{-8}	2×10^{-4}
	Ba 140	S	1×10^{-7}	8×10^{-4}	4×10^{-9}	3×10^{-5}
		I	4×10^{-8}	7×10^{-4}	1×10^{-9}	2×10^{-5}
Berkelium (97)	Bk 249	S	9×10^{-10}	2×10^{-2}	3×10^{-11}	6×10^{-4}
		I	1×10^{-7}	2×10^{-2}	4×10^{-9}	6×10^{-4}
	Bk 250	S	1×10^{-7}	6×10^{-3}	5×10^{-9}	2×10^{-4}
		I	1×10^{-6}	6×10^{-3}	4×10^{-8}	2×10^{-4}
Beryllium (4)	Be 7	S	6×10^{-6}	5×10^{-2}	2×10^{-7}	2×10^{-3}
		I	1×10^{-6}	5×10^{-2}	4×10^{-8}	2×10^{-3}
Bismuth (83)	Bi 206	S	2×10^{-7}	1×10^{-3}	6×10^{-9}	4×10^{-5}
		I	1×10^{-7}	1×10^{-3}	5×10^{-9}	4×10^{-5}
	Bi 207	S	2×10^{-7}	2×10^{-3}	6×10^{-9}	6×10^{-5}
		I	1×10^{-8}	2×10^{-3}	5×10^{-10}	6×10^{-5}
	Bi 210	S	6×10^{-9}	1×10^{-3}	2×10^{-10}	4×10^{-5}
		I	6×10^{-9}	1×10^{-3}	2×10^{-10}	4×10^{-5}
	Bi 212	S	1×10^{-7}	1×10^{-2}	3×10^{-9}	4×10^{-4}
		I	2×10^{-7}	1×10^{-2}	7×10^{-9}	4×10^{-4}

25 FR 10914

APPENDIX B

Concentrations in Air and Water Above Natural Background—Continued

(See footnotes on page 20-15)

Element (atomic number)	Isotope [1]	†	Table I Column 1 Air (μCi/ml)	Table I Column 2 Water (μCi/ml)	Table II Column 1 Air (μCi/ml)	Table II Column 2 Water (μCi/ml)
Bromine (35)	Br 82	S	1×10^{-6}	8×10^{-3}	4×10^{-8}	3×10^{-4}
		I	2×10^{-7}	1×10^{-3}	6×10^{-9}	4×10^{-5}
Cadmium (48)	Cd 109	S	5×10^{-8}	5×10^{-3}	2×10^{-9}	2×10^{-4}
		I	7×10^{-8}	5×10^{-3}	3×10^{-9}	2×10^{-4}
	Cd 115m	S	4×10^{-8}	7×10^{-4}	1×10^{-9}	3×10^{-5}
		I	4×10^{-8}	7×10^{-4}	1×10^{-9}	3×10^{-5}
	Cd 115	S	2×10^{-7}	1×10^{-3}	8×10^{-9}	3×10^{-5}
		I	2×10^{-7}	1×10^{-3}	6×10^{-9}	4×10^{-5}
Calcium (20)	Ca 45	S	3×10^{-8}	3×10^{-4}	1×10^{-9}	9×10^{-6}
		I	1×10^{-7}	5×10^{-3}	4×10^{-9}	2×10^{-4}
	Ca 47	S	2×10^{-7}	1×10^{-3}	6×10^{-9}	5×10^{-5}
		I	2×10^{-7}	1×10^{-3}	6×10^{-9}	3×10^{-5}
Californium (98)	Cf 249	S	2×10^{-12}	1×10^{-4}	5×10^{-14}	4×10^{-6}
		I	1×10^{-10}	7×10^{-4}	3×10^{-12}	2×10^{-5}
	Cf 250	S	5×10^{-12}	4×10^{-4}	2×10^{-13}	1×10^{-5}
		I	1×10^{-10}	7×10^{-4}	3×10^{-12}	3×10^{-5}
	Cf 251	S	2×10^{-12}	1×10^{-4}	6×10^{-14}	4×10^{-6}
		I	1×10^{-10}	8×10^{-4}	3×10^{-12}	3×10^{-5}
	Cf 252	* S	6×10^{-12}	2×10^{-4}	2×10^{-13}	7×10^{-6}
		* I	3×10^{-11}	2×10^{-4}	1×10^{-12}	7×10^{-6}
	Cf 253	S	8×10^{-10}	4×10^{-3}	3×10^{-11}	1×10^{-4}
		I	8×10^{-10}	4×10^{-3}	3×10^{-11}	1×10^{-4}
	Cf 254	S	5×10^{-12}	4×10^{-6}	2×10^{-13}	1×10^{-7}
		I	5×10^{-12}	4×10^{-6}	2×10^{-13}	1×10^{-7}
Carbon (6)	C 14	S	4×10^{-6}	2×10^{-2}	1×10^{-7}	8×10^{-4}
	(CO_2)	Sub	5×10^{-5}	...	1×10^{-6}	...
Cerium (58)	Ce 141	S	4×10^{-7}	3×10^{-3}	2×10^{-8}	9×10^{-5}
		I	2×10^{-7}	3×10^{-3}	5×10^{-9}	9×10^{-5}
	Ce 143	S	3×10^{-7}	1×10^{-3}	9×10^{-9}	4×10^{-5}
		I	2×10^{-7}	1×10^{-3}	7×10^{-9}	4×10^{-5}
	Ce 144	S	1×10^{-8}	3×10^{-4}	3×10^{-10}	1×10^{-5}
		I	6×10^{-9}	3×10^{-4}	2×10^{-10}	1×10^{-5}
Cesium (55)	Cs 131	S	1×10^{-5}	7×10^{-2}	4×10^{-7}	2×10^{-3}
		I	3×10^{-6}	3×10^{-2}	1×10^{-7}	9×10^{-4}
	Cs 134m	S	4×10^{-5}	2×10^{-1}	1×10^{-6}	6×10^{-3}
		I	6×10^{-6}	3×10^{-2}	2×10^{-7}	1×10^{-3}
	Cs 134	S	4×10^{-8}	3×10^{-4}	1×10^{-9}	9×10^{-6}
		I	1×10^{-8}	1×10^{-3}	4×10^{-10}	4×10^{-5}
	Cs 135	S	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	9×10^{-8}	7×10^{-3}	3×10^{-9}	2×10^{-4}
	Cs 136	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	9×10^{-5}
		I	2×10^{-7}	2×10^{-3}	6×10^{-9}	6×10^{-5}
	Cs 137	S	6×10^{-8}	4×10^{-4}	2×10^{-9}	2×10^{-5}
		I	1×10^{-8}	1×10^{-3}	5×10^{-10}	4×10^{-5}
Chlorine (17)	Cl 36	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	8×10^{-5}
		I	2×10^{-8}	2×10^{-3}	8×10^{-10}	6×10^{-5}
	Cl 38	S	3×10^{-6}	1×10^{-2}	9×10^{-8}	4×10^{-4}
		I	2×10^{-6}	1×10^{-2}	7×10^{-8}	4×10^{-4}
Chromium (24)	Cr 51	S	1×10^{-5}	5×10^{-2}	4×10^{-7}	2×10^{-3}
		I	2×10^{-6}	5×10^{-2}	8×10^{-8}	2×10^{-3}

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APPENDIX B

Concentrations in Air and Water Above Natural Background—Continued

(See footnotes on page 20-15)

Element (atomic number)	Isotope [1]	†	Table I Column 1 Air (μCi/ml)	Table I Column 2 Water (μCi/ml)	Table II Column 1 Air (μCi/ml)	Table II Column 2 Water (μCi/ml)
Cobalt (27)	Co 57	S	3×10^{-6}	2×10^{-2}	1×10^{-7}	5×10^{-4}
		I	2×10^{-7}	1×10^{-2}	6×10^{-9}	4×10^{-4}
	Co 58m	S	2×10^{-5}	8×10^{-2}	6×10^{-7}	3×10^{-3}
		I	9×10^{-6}	6×10^{-2}	3×10^{-7}	2×10^{-3}
	Co 58	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
		I	5×10^{-8}	3×10^{-3}	2×10^{-9}	9×10^{-5}
	Co 60	S	3×10^{-7}	1×10^{-3}	1×10^{-8}	5×10^{-5}
		I	9×10^{-9}	1×10^{-3}	3×10^{-10}	3×10^{-5}
Copper (29)	Cu 64	S	2×10^{-6}	1×10^{-2}	7×10^{-8}	3×10^{-4}
		I	1×10^{-6}	6×10^{-3}	4×10^{-8}	2×10^{-4}
Curium (96)	Cm 242	S	1×10^{-10}	7×10^{-4}	4×10^{-12}	2×10^{-5}
		I	2×10^{-10}	7×10^{-4}	6×10^{-12}	2×10^{-5}
	Cm 243	S	6×10^{-12}	1×10^{-4}	2×10^{-13}	5×10^{-6}
		I	1×10^{-10}	7×10^{-4}	3×10^{-12}	2×10^{-5}
	Cm 244	S	9×10^{-12}	2×10^{-4}	3×10^{-13}	7×10^{-6}
		I	1×10^{-10}	8×10^{-4}	3×10^{-12}	3×10^{-5}
	Cm 245	S	5×10^{-12}	1×10^{-4}	2×10^{-13}	4×10^{-6}
		I	1×10^{-10}	8×10^{-4}	4×10^{-12}	3×10^{-5}
	Cm 246	S	5×10^{-12}	1×10^{-4}	2×10^{-13}	4×10^{-6}
		I	1×10^{-10}	8×10^{-4}	4×10^{-12}	3×10^{-5}
	Cm 247	S	5×10^{-12}	1×10^{-4}	2×10^{-13}	4×10^{-6}
		I	1×10^{-10}	6×10^{-4}	4×10^{-12}	2×10^{-5}
	Cm 248	S	6×10^{-13}	1×10^{-5}	2×10^{-14}	4×10^{-7}
		I	1×10^{-11}	4×10^{-5}	4×10^{-13}	1×10^{-6}
	Cm 249	S	1×10^{-5}	6×10^{-2}	4×10^{-7}	2×10^{-3}
		I	1×10^{-5}	6×10^{-2}	4×10^{-7}	2×10^{-3}
Dysprosium (66)	Dy 165	S	3×10^{-6}	1×10^{-2}	9×10^{-8}	4×10^{-4}
		I	2×10^{-6}	1×10^{-2}	7×10^{-8}	4×10^{-4}
	Dy 166	S	2×10^{-7}	1×10^{-3}	8×10^{-9}	4×10^{-5}
		I	2×10^{-7}	1×10^{-3}	7×10^{-9}	4×10^{-5}
Einsteinium (99)	Es 253	S	8×10^{-10}	7×10^{-4}	3×10^{-11}	2×10^{-5}
		I	6×10^{-10}	7×10^{-4}	2×10^{-11}	2×10^{-5}
	Es 254m	S	5×10^{-9}	5×10^{-4}	2×10^{-10}	2×10^{-5}
		I	6×10^{-9}	5×10^{-4}	2×10^{-10}	2×10^{-5}
	Es 254	S	2×10^{-11}	4×10^{-4}	6×10^{-13}	1×10^{-5}
		I	1×10^{-10}	4×10^{-4}	4×10^{-12}	1×10^{-5}
	Es 255	S	5×10^{-10}	8×10^{-4}	2×10^{-11}	3×10^{-5}
		I	4×10^{-10}	8×10^{-4}	1×10^{-11}	3×10^{-5}
Erbium (68)	Er 169	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	9×10^{-5}
		I	4×10^{-7}	3×10^{-3}	1×10^{-8}	9×10^{-5}
	Er 171	S	7×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
Europium (63)	Eu 152	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
	(T/2 = 9.2 hrs)	I	3×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
	Eu 152	S	1×10^{-8}	2×10^{-3}	4×10^{-10}	8×10^{-5}
	(T/2 = 13 yrs)	I	2×10^{-8}	2×10^{-3}	6×10^{-10}	8×10^{-5}
	Eu 154	S	4×10^{-9}	6×10^{-4}	1×10^{-10}	2×10^{-5}
		I	7×10^{-9}	6×10^{-4}	2×10^{-10}	2×10^{-5}
	Eu 155	S	9×10^{-8}	6×10^{-3}	3×10^{-9}	2×10^{-4}
		I	7×10^{-8}	6×10^{-3}	3×10^{-9}	2×10^{-4}

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APPENDIX B

Concentrations in Air and Water Above Natural Background—Continued

(See footnotes on page 20-15)

Element (atomic number)	Isotope [1]	†	Table I Column 1 Air (μCi/ml)	Table I Column 2 Water (μCi/ml)	Table II Column 1 Air (μCi/ml)	Table II Column 2 Water (μCi/ml)
Fermium (100)	Fm 254	S	6×10^{-8}	4×10^{-3}	2×10^{-9}	1×10^{-4}
		I	7×10^{-8}	4×10^{-3}	2×10^{-9}	1×10^{-4}
	Fm 255	S	2×10^{-8}	1×10^{-3}	6×10^{-10}	3×10^{-5}
		I	1×10^{-8}	1×10^{-3}	4×10^{-10}	3×10^{-5}
	Fm 256	S	3×10^{-9}	3×10^{-5}	1×10^{-10}	9×10^{-7}
		I	2×10^{-9}	3×10^{-5}	6×10^{-11}	9×10^{-7}
Fluorine (9)	F 18	S	5×10^{-6}	2×10^{-2}	2×10^{-7}	8×10^{-4}
		I	3×10^{-6}	1×10^{-2}	9×10^{-8}	5×10^{-4}
Gadolinium (64)	Gd 153	S	2×10^{-7}	6×10^{-3}	8×10^{-9}	2×10^{-4}
		I	9×10^{-8}	6×10^{-3}	3×10^{-9}	2×10^{-4}
	Gd 159	S	5×10^{-7}	2×10^{-3}	2×10^{-8}	8×10^{-5}
		I	4×10^{-7}	2×10^{-3}	1×10^{-8}	8×10^{-5}
Gallium (31)	Ga 72	S	2×10^{-7}	1×10^{-3}	8×10^{-9}	4×10^{-5}
		I	2×10^{-7}	1×10^{-3}	6×10^{-9}	4×10^{-5}
Germanium (32)	Ge 71	S	1×10^{-5}	5×10^{-2}	4×10^{-7}	2×10^{-3}
		I	6×10^{-6}	5×10^{-2}	2×10^{-7}	2×10^{-3}
Gold (79)	Au 196	S	1×10^{-6}	5×10^{-3}	4×10^{-8}	2×10^{-4}
		I	6×10^{-7}	4×10^{-3}	2×10^{-8}	1×10^{-4}
	Au 198	S	3×10^{-7}	2×10^{-3}	1×10^{-8}	5×10^{-5}
		I	2×10^{-7}	1×10^{-3}	8×10^{-9}	5×10^{-5}
	Au 199	S	1×10^{-6}	5×10^{-3}	4×10^{-8}	2×10^{-4}
		I	8×10^{-7}	4×10^{-3}	3×10^{-8}	2×10^{-4}
Hafnium (72)	Hf 181	S	4×10^{-8}	2×10^{-3}	1×10^{-9}	7×10^{-5}
		I	7×10^{-8}	2×10^{-3}	3×10^{-9}	7×10^{-5}
Holmium (67)	Ho 166	S	2×10^{-7}	9×10^{-4}	7×10^{-9}	3×10^{-5}
		I	2×10^{-7}	9×10^{-4}	6×10^{-9}	3×10^{-5}
Hydrogen (1)	H3	S	5×10^{-6}	1×10^{-1}	2×10^{-7}	3×10^{-3}
		I	5×10^{-6}	1×10^{-1}	2×10^{-7}	3×10^{-3}
		Sub	2×10^{-3}	------	4×10^{-5}	------
Indium (49)	In 113m	S	8×10^{-6}	4×10^{-2}	3×10^{-7}	1×10^{-3}
		I	7×10^{-6}	4×10^{-2}	2×10^{-7}	1×10^{-3}
	In 114m	S	1×10^{-7}	5×10^{-4}	4×10^{-9}	2×10^{-5}
		I	2×10^{-8}	5×10^{-4}	7×10^{-10}	2×10^{-5}
	In 115m	S	2×10^{-6}	1×10^{-2}	8×10^{-8}	4×10^{-4}
		I	2×10^{-6}	1×10^{-2}	6×10^{-8}	4×10^{-4}
	In 115	S	2×10^{-7}	3×10^{-3}	9×10^{-9}	9×10^{-5}
		I	3×10^{-8}	3×10^{-3}	1×10^{-9}	9×10^{-5}
Iodine (53)	I 125	S	5×10^{-9}	4×10^{-5}	8×10^{-11}	2×10^{-7}
		I	2×10^{-7}	6×10^{-3}	6×10^{-9}	2×10^{-4}
	I 126	S	8×10^{-9}	5×10^{-5}	9×10^{-11}	3×10^{-7}
		I	3×10^{-7}	3×10^{-3}	1×10^{-8}	9×10^{-5}
	I 129	S	2×10^{-9}	1×10^{-5}	2×10^{-11}	6×10^{-8}
		I	7×10^{-8}	6×10^{-3}	2×10^{-9}	2×10^{-4}
	I 131	S	9×10^{-9}	6×10^{-5}	1×10^{-10}	3×10^{-7}
		I	3×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
	I 132	S	2×10^{-7}	2×10^{-3}	3×10^{-9}	8×10^{-6}
		I	9×10^{-7}	5×10^{-3}	3×10^{-8}	2×10^{-4}
	I 133	S	3×10^{-8}	2×10^{-4}	4×10^{-10}	1×10^{-6}
		I	2×10^{-7}	1×10^{-3}	7×10^{-9}	4×10^{-5}
	I 134	S	5×10^{-7}	4×10^{-3}	6×10^{-9}	2×10^{-5}

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Concentrations in Air and Water Above Natural Background—Continued

(See footnotes on page 20-15)

Element (atomic number)	Isotope [1]	†	Table I Column 1 Air (μCi/ml)	Table I Column 2 Water (μCi/ml)	Table II Column 1 Air (μCi/ml)	Table II Column 2 Water (μCi/ml)
Iodine (53)	I 134	I	3×10^{-6}	2×10^{-2}	1×10^{-7}	6×10^{-4}
	I 135	S	1×10^{-7}	7×10^{-4}	1×10^{-9}	4×10^{-6}
		I	4×10^{-7}	2×10^{-3}	1×10^{-8}	7×10^{-5}
Iridium (77)	Ir 190	S	1×10^{-6}	6×10^{-3}	4×10^{-8}	2×10^{-4}
		I	4×10^{-7}	5×10^{-3}	1×10^{-8}	2×10^{-4}
	Ir 192	S	1×10^{-7}	1×10^{-3}	4×10^{-9}	4×10^{-5}
		I	3×10^{-8}	1×10^{-3}	9×10^{-10}	4×10^{-5}
	Ir 194	S	2×10^{-7}	1×10^{-3}	8×10^{-9}	3×10^{-5}
		I	2×10^{-7}	9×10^{-4}	5×10^{-9}	3×10^{-5}
Iron (26)	Fe 55	S	9×10^{-7}	2×10^{-2}	3×10^{-8}	8×10^{-4}
		I	1×10^{-6}	7×10^{-2}	3×10^{-8}	2×10^{-3}
	Fe 59	S	1×10^{-7}	2×10^{-3}	5×10^{-9}	6×10^{-5}
		I	5×10^{-8}	2×10^{-3}	2×10^{-9}	5×10^{-5}
Krypton (36)	Kr 85m	Sub	6×10^{-6}	....	1×10^{-7}	....
	Kr 85	Sub	1×10^{-5}	....	3×10^{-7}	....
	Kr 87	Sub	1×10^{-6}	....	2×10^{-8}	....
	Kr 88	Sub	1×10^{-6}	....	2×10^{-8}	....
Lanthanum (57)	La 140	S	2×10^{-7}	7×10^{-4}	5×10^{-9}	2×10^{-5}
		I	1×10^{-7}	7×10^{-4}	4×10^{-9}	2×10^{-5}
Lead (82)	Pb 203	S	3×10^{-6}	1×10^{-2}	9×10^{-8}	4×10^{-4}
		I	2×10^{-6}	1×10^{-2}	6×10^{-8}	4×10^{-4}
	Pb 210	S	1×10^{-10}	4×10^{-6}	4×10^{-12}	1×10^{-7}
		I	2×10^{-10}	5×10^{-3}	8×10^{-12}	2×10^{-4}
	Pb 212	S	2×10^{-8}	6×10^{-4}	6×10^{-10}	2×10^{-5}
		I	2×10^{-8}	5×10^{-4}	7×10^{-10}	2×10^{-5}
Lutetium (71)	Lu 177	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
Manganese (25)	Mn 52	S	2×10^{-7}	1×10^{-3}	7×10^{-9}	3×10^{-5}
		I	1×10^{-7}	9×10^{-4}	5×10^{-9}	3×10^{-5}
	Mn 54	* S	4×10^{-7}	4×10^{-3}	1×10^{-8}	1×10^{-4}
		I	4×10^{-8}	3×10^{-3}	1×10^{-9}	1×10^{-4}
	Mn 56	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
		I	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
Mercury (80)	Hg 197m	S	7×10^{-7}	6×10^{-3}	3×10^{-8}	2×10^{-4}
		I	8×10^{-7}	5×10^{-3}	3×10^{-8}	2×10^{-4}
	Hg 197	S	1×10^{-6}	9×10^{-3}	4×10^{-8}	3×10^{-4}
		I	3×10^{-6}	1×10^{-2}	9×10^{-8}	5×10^{-4}
	Hg 203	S	7×10^{-8}	5×10^{-4}	2×10^{-9}	2×10^{-5}
		I	1×10^{-7}	3×10^{-3}	4×10^{-9}	1×10^{-4}
Molybdenum (42)	Mo 99	S	7×10^{-7}	5×10^{-3}	3×10^{-8}	2×10^{-4}
		I	2×10^{-7}	1×10^{-3}	7×10^{-9}	4×10^{-5}
Neodymium (60)	Nd 144	S	8×10^{-11}	2×10^{-3}	3×10^{-12}	7×10^{-5}
		I	3×10^{-10}	2×10^{-3}	1×10^{-11}	8×10^{-5}
	Nd 147	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
		I	2×10^{-7}	2×10^{-3}	8×10^{-9}	6×10^{-5}
	Nd 149	S	2×10^{-6}	8×10^{-3}	6×10^{-8}	3×10^{-4}
		I	1×10^{-6}	8×10^{-3}	5×10^{-8}	3×10^{-4}

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Concentrations in Air and Water Above Natural Background—Continued

(See footnotes on page 20-15)

Element (atomic number)	Isotope [1]	†	Table I Column 1 Air (μCi/ml)	Table I Column 2 Water (μCi/ml)	Table II Column 1 Air (μCi/ml)	Table II Column 2 Water (μCi/ml)
Neptunium (93)	Np 237	S	4×10^{-12}	9×10^{-5}	1×10^{-13}	3×10^{-6}
		I	1×10^{-10}	9×10^{-4}	4×10^{-12}	3×10^{-5}
	Np 239	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
		I	7×10^{-7}	4×10^{-3}	2×10^{-8}	1×10^{-4}
Nickel (28)	Ni 59	S	5×10^{-7}	6×10^{-3}	2×10^{-8}	2×10^{-4}
		I	8×10^{-7}	6×10^{-2}	3×10^{-8}	2×10^{-3}
	Ni 63	S	6×10^{-8}	8×10^{-4}	2×10^{-9}	3×10^{-5}
		I	3×10^{-7}	2×10^{-2}	1×10^{-8}	7×10^{-4}
	Ni 65	S	9×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
		I	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
Niobium (Columbium) (41)	Nb 93m	S	1×10^{-7}	1×10^{-2}	4×10^{-9}	4×10^{-4}
		I	2×10^{-7}	1×10^{-2}	5×10^{-9}	4×10^{-4}
	Nb 95	S	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	1×10^{-7}	3×10^{-3}	3×10^{-9}	1×10^{-4}
	Nb 97	S	6×10^{-6}	3×10^{-2}	2×10^{-7}	9×10^{-4}
		I	5×10^{-6}	3×10^{-2}	2×10^{-7}	9×10^{-4}
Osmium (76)	Os 185	S	5×10^{-7}	2×10^{-3}	2×10^{-8}	7×10^{-5}
		I	5×10^{-8}	2×10^{-3}	2×10^{-9}	7×10^{-5}
	Os 191m	S	2×10^{-5}	7×10^{-2}	6×10^{-7}	3×10^{-3}
		I	9×10^{-6}	7×10^{-2}	3×10^{-7}	2×10^{-3}
	Os 191	S	1×10^{-6}	5×10^{-3}	4×10^{-8}	2×10^{-4}
		I	4×10^{-7}	5×10^{-3}	1×10^{-8}	2×10^{-4}
	Os 193	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
		I	3×10^{-7}	2×10^{-3}	9×10^{-9}	5×10^{-5}
Palladium (46)	Pd 103	S	1×10^{-6}	1×10^{-2}	5×10^{-8}	3×10^{-4}
		I	7×10^{-7}	8×10^{-3}	3×10^{-8}	3×10^{-4}
	Pd 109	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	9×10^{-5}
		I	4×10^{-7}	2×10^{-3}	1×10^{-8}	7×10^{-5}
Phosphorus (15)	P 32	S	7×10^{-8}	5×10^{-4}	2×10^{-9}	2×10^{-5}
		I	8×10^{-8}	7×10^{-4}	3×10^{-9}	2×10^{-5}
Platinum (78)	Pt 191	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
		I	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
	Pt 193m	S	7×10^{-6}	3×10^{-2}	2×10^{-7}	1×10^{-3}
		I	5×10^{-6}	3×10^{-2}	2×10^{-7}	1×10^{-3}
*	Pt 193	S	1×10^{-6}	3×10^{-2}	4×10^{-8}	9×10^{-4}
		I	3×10^{-7}	5×10^{-2}	1×10^{-8}	2×10^{-3}
	Pt 197m	S	6×10^{-6}	3×10^{-2}	2×10^{-7}	1×10^{-3}
		I	5×10^{-6}	3×10^{-2}	2×10^{-7}	9×10^{-4}
	Pt 197	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
		I	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
Plutonium (94)	Pu 238	S	2×10^{-12}	1×10^{-4}	7×10^{-14}	5×10^{-6}
		I	3×10^{-11}	8×10^{-4}	1×10^{-12}	3×10^{-5}
	Pu 239	S	2×10^{-12}	1×10^{-4}	6×10^{-14}	5×10^{-6}
		I	4×10^{-11}	8×10^{-4}	1×10^{-12}	3×10^{-5}
	Pu 240	S	2×10^{-12}	1×10^{-4}	6×10^{-14}	5×10^{-6}
		I	4×10^{-11}	8×10^{-4}	1×10^{-12}	3×10^{-5}
	Pu 241	S	9×10^{-11}	7×10^{-3}	3×10^{-12}	2×10^{-4}
		I	4×10^{-8}	4×10^{-2}	1×10^{-9}	1×10^{-3}

APPENDIX B

Concentrations in Air and Water Above Natural Background—Continued

(See footnotes on page 20-15)

Element (atomic number)	Isotope [1]	†	Table I Column 1 Air (μCi/ml)	Table I Column 2 Water (μCi/ml)	Table II Column 1 Air (μCi/ml)	Table II Column 2 Water (μCi/ml)
Plutonium (94)	Pu 242	S	2×10^{-12}	1×10^{-4}	6×10^{-14}	5×10^{-6}
		I	4×10^{-11}	9×10^{-4}	1×10^{-12}	3×10^{-5}
	Pu 243	S	2×10^{-6}	1×10^{-2}	6×10^{-8}	3×10^{-4}
		I	2×10^{-6}	1×10^{-2}	8×10^{-8}	3×10^{-4}
	Pu 244	S	2×10^{-12}	1×10^{-4}	6×10^{-14}	4×10^{-6}
		I	3×10^{-11}	3×10^{-4}	1×10^{-12}	1×10^{-5}
Polonium (84)	Po 210	S	5×10^{-10}	2×10^{-5}	2×10^{-11}	7×10^{-7}
		I	2×10^{-10}	8×10^{-4}	7×10^{-12}	3×10^{-5}
Potassium (19)	K 42	S	2×10^{-6}	9×10^{-3}	7×10^{-8}	3×10^{-4}
		I	1×10^{-7}	6×10^{-4}	4×10^{-9}	2×10^{-5}
Praseodymium (59)	Pr 142	S	2×10^{-7}	9×10^{-4}	7×10^{-9}	3×10^{-5}
		I	2×10^{-7}	9×10^{-4}	5×10^{-9}	3×10^{-5}
	Pr 143	S	3×10^{-7}	1×10^{-3}	1×10^{-8}	5×10^{-5}
		I	2×10^{-7}	1×10^{-3}	6×10^{-9}	5×10^{-5}
Promethium (61)	Pm 147	S	6×10^{-8}	6×10^{-3}	2×10^{-9}	2×10^{-4}
		I	1×10^{-7}	6×10^{-3}	3×10^{-9}	2×10^{-4}
	Pm 149	S	3×10^{-7}	1×10^{-3}	1×10^{-8}	4×10^{-5}
		I	2×10^{-7}	1×10^{-3}	8×10^{-9}	4×10^{-5}
Protoactinium (91)	Pa 230	S	2×10^{-9}	7×10^{-3}	6×10^{-11}	2×10^{-4}
		I	8×10^{-10}	7×10^{-3}	3×10^{-11}	2×10^{-4}
	Pa 231	S	1×10^{-12}	3×10^{-5}	4×10^{-14}	9×10^{-7}
		I	1×10^{-10}	8×10^{-4}	4×10^{-12}	2×10^{-5}
	Pa 233	S	6×10^{-7}	4×10^{-3}	2×10^{-8}	1×10^{-4}
		I	2×10^{-7}	3×10^{-3}	6×10^{-9}	1×10^{-4}
Radium (88)	Ra 223	S	2×10^{-9}	2×10^{-5}	6×10^{-11}	7×10^{-7}
		I	2×10^{-10}	1×10^{-4}	8×10^{-12}	4×10^{-6}
	Ra 224	S	5×10^{-9}	7×10^{-5}	2×10^{-10}	2×10^{-6}
		I	7×10^{-10}	2×10^{-4}	2×10^{-11}	5×10^{-6}
	Ra 226	S	3×10^{-11}	4×10^{-7}	3×10^{-12}	3×10^{-8}
		I	5×10^{-11}	9×10^{-4}	2×10^{-12}	3×10^{-5}
	Ra 228	S	7×10^{-11}	8×10^{-7}	2×10^{-12}	3×10^{-8}
		I	4×10^{-11}	7×10^{-4}	1×10^{-12}	3×10^{-5}
Radon (86)	Rn 220	S	3×10^{-7}	....	1×10^{-8}	....
	≫ Rn 222[3] ***	S	*** 3×10^{-8}	....	3×10^{-9}	....
Rhenium (75)	Re 183	S	3×10^{-6}	2×10^{-2}	9×10^{-8}	6×10^{-4}
		I	2×10^{-7}	8×10^{-3}	5×10^{-9}	3×10^{-4}
	Re 186	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	9×10^{-5}
		I	2×10^{-7}	1×10^{-3}	8×10^{-9}	5×10^{-5}
	Re 187	S	9×10^{-6}	7×10^{-2}	3×10^{-7}	3×10^{-3}
		I	5×10^{-7}	4×10^{-2}	2×10^{-8}	2×10^{-3}
	Re 188	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
		I	2×10^{-7}	9×10^{-4}	6×10^{-9}	3×10^{-5}
Rhodium (45)	Rh 103m	S	8×10^{-5}	4×10^{-1}	3×10^{-6}	1×10^{-2}
		I	6×10^{-5}	3×10^{-1}	2×10^{-6}	1×10^{-2}
	Rh 105	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
		I	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
Rubidium (37)	Rb 86	S	3×10^{-7}	2×10^{-3}	1×10^{-8}	7×10^{-5}
		I	7×10^{-8}	7×10^{-4}	2×10^{-9}	2×10^{-5}
	Rb 87	S	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	7×10^{-8}	5×10^{-3}	2×10^{-9}	2×10^{-4}

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Concentrations in Air and Water Above Natural Background—Continued

(See footnotes on page 20-15)

Element (atomic number)	Isotope [1]	†	Table I Column 1 Air (μCi/ml)	Table I Column 2 Water (μCi/ml)	Table II Column 1 Air (μCi/ml)	Table II Column 2 Water (μCi/ml)
Ruthenium (44)	Ru 97	S	2×10^{-6}	1×10^{-2}	8×10^{-8}	4×10^{-4}
		I	2×10^{-6}	1×10^{-2}	6×10^{-8}	3×10^{-4}
	Ru 103	S	5×10^{-7}	2×10^{-3}	2×10^{-8}	8×10^{-5}
		I	8×10^{-8}	2×10^{-3}	3×10^{-9}	8×10^{-5}
	Ru 105	S	7×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
	Ru 106	S	8×10^{-8}	4×10^{-4}	3×10^{-9}	1×10^{-5}
		I	6×10^{-9}	3×10^{-4}	2×10^{-10}	1×10^{-5}
Samarium (62)	Sm 147	S	7×10^{-11}	2×10^{-3}	2×10^{-12}	6×10^{-5}
		I	3×10^{-10}	2×10^{-3}	9×10^{-12}	7×10^{-5}
	Sm 151	S	6×10^{-8}	1×10^{-2}	2×10^{-9}	4×10^{-4}
		I	1×10^{-7}	1×10^{-2}	5×10^{-9}	4×10^{-4}
	Sm 153	S	5×10^{-7}	2×10^{-3}	2×10^{-8}	8×10^{-5}
		I	4×10^{-7}	2×10^{-3}	1×10^{-8}	8×10^{-5}
Scandium (21)	Sc 46	S	2×10^{-7}	1×10^{-3}	8×10^{-9}	4×10^{-5}
		I	2×10^{-8}	1×10^{-3}	8×10^{-10}	4×10^{-5}
	Sc 47	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	9×10^{-5}
		I	5×10^{-7}	3×10^{-3}	2×10^{-8}	9×10^{-5}
	Sc 48	S	2×10^{-7}	8×10^{-4}	6×10^{-9}	3×10^{-5}
		I	1×10^{-7}	8×10^{-4}	5×10^{-9}	3×10^{-5}
Selenium (34)	Se 75	S	1×10^{-6}	9×10^{-3}	4×10^{-8}	3×10^{-4}
		I	1×10^{-7}	8×10^{-3}	4×10^{-9}	3×10^{-4}
Silicon (14)	Si 31	S	6×10^{-6}	3×10^{-2}	2×10^{-7}	9×10^{-4}
		I	1×10^{-6}	6×10^{-3}	3×10^{-8}	2×10^{-4}
Silver (47)	Ag 105	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	8×10^{-8}	3×10^{-3}	3×10^{-9}	1×10^{-4}
	Ag 110m	S	2×10^{-7}	9×10^{-4}	7×10^{-9}	3×10^{-5}
		I	1×10^{-8}	9×10^{-4}	3×10^{-10}	3×10^{-5}
	Ag 111	S	3×10^{-7}	1×10^{-3}	1×10^{-8}	4×10^{-5}
		I	2×10^{-7}	1×10^{-3}	8×10^{-9}	4×10^{-5}
Sodium (11)	Na 22	S	2×10^{-7}	1×10^{-3}	6×10^{-9}	4×10^{-5}
		I	9×10^{-9}	9×10^{-4}	3×10^{-10}	3×10^{-5}
	Na 24	S	1×10^{-6}	6×10^{-3}	4×10^{-8}	2×10^{-4}
		I	1×10^{-7}	8×10^{-4}	5×10^{-9}	3×10^{-5}
Strontium (38)	Sr 85m	S	4×10^{-5}	2×10^{-1}	1×10^{-6}	7×10^{-3}
		I	3×10^{-5}	2×10^{-1}	1×10^{-6}	7×10^{-3}
	Sr 85	S	2×10^{-7}	3×10^{-3}	8×10^{-9}	1×10^{-4}
		I	1×10^{-7}	5×10^{-3}	4×10^{-9}	2×10^{-4}
	Sr 89	S	3×10^{-8}	3×10^{-4}	3×10^{-10}	3×10^{-6}
		I	4×10^{-8}	8×10^{-4}	1×10^{-9}	3×10^{-5}
	Sr 90	S	1×10^{-9}	1×10^{-5}	3×10^{-11}	3×10^{-7}
		I	5×10^{-9}	1×10^{-3}	2×10^{-10}	4×10^{-5}
	Sr 91	S	4×10^{-7}	2×10^{-3}	2×10^{-8}	7×10^{-5}
		I	3×10^{-7}	1×10^{-3}	9×10^{-9}	5×10^{-5}
	Sr 92	S	4×10^{-7}	2×10^{-3}	2×10^{-8}	7×10^{-5}
		I	3×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
Sulfur (16)	S 35	S	3×10^{-7}	2×10^{-3}	9×10^{-9}	6×10^{-5}
		I	3×10^{-7}	8×10^{-3}	9×10^{-9}	3×10^{-4}
Tantalum (73)	Ta 182	S	4×10^{-8}	1×10^{-3}	1×10^{-9}	4×10^{-5}
		I	2×10^{-8}	1×10^{-3}	7×10^{-10}	4×10^{-5}

25 FR 10914

NOTE: Amendments made by 40 FR 50704 become effective 1/29/76.

APPENDIX B

Concentrations in Air and Water Above Natural Background—Continued

(See footnotes on page 20-15)

Element (atomic number)		Isotope[1]	†	Table I Column 1 Air (μCi/ml)	Table I Column 2 Water (μCi/ml)	Table II Column 1 Air (μCi/ml)	Table II Column 2 Water (μCi/ml)
Technetium (43)		Tc 96m	S	8×10^{-5}	4×10^{-1}	3×10^{-6}	1×10^{-3}
			I	3×10^{-5}	3×10^{-1}	1×10^{-6}	1×10^{-3}
		Tc 96	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
			I	2×10^{-7}	1×10^{-3}	8×10^{-9}	5×10^{-5}
		Tc 97m	S	2×10^{-6}	1×10^{-2}	8×10^{-8}	4×10^{-4}
			I	2×10^{-7}	5×10^{-3}	5×10^{-9}	2×10^{-4}
		Tc 97	S	1×10^{-5}	5×10^{-2}	4×10^{-7}	2×10^{-3}
			I	3×10^{-7}	2×10^{-2}	1×10^{-8}	8×10^{-4}
		Tc 99m	S	4×10^{-5}	2×10^{-1}	1×10^{-6}	6×10^{-3}
			I	1×10^{-5}	8×10^{-2}	5×10^{-7}	3×10^{-3}
		Tc 99	S	2×10^{-6}	1×10^{-2}	7×10^{-8}	3×10^{-4}
			I	6×10^{-8}	5×10^{-3}	2×10^{-9}	2×10^{-4}
Tellurium (52)		Te 125m	S	4×10^{-7}	5×10^{-3}	1×10^{-8}	2×10^{-4}
			I	1×10^{-7}	3×10^{-3}	4×10^{-9}	1×10^{-4}
		Te 127m	S	1×10^{-7}	2×10^{-3}	5×10^{-9}	6×10^{-5}
			I	4×10^{-8}	2×10^{-3}	1×10^{-9}	5×10^{-5}
		Te 127	S	2×10^{-6}	8×10^{-3}	6×10^{-8}	3×10^{-4}
			I	9×10^{-7}	5×10^{-3}	3×10^{-8}	2×10^{-4}
		Te 129m	S	8×10^{-8}	1×10^{-3}	3×10^{-9}	3×10^{-5}
			I	3×10^{-8}	6×10^{-4}	1×10^{-9}	2×10^{-5}
		Te 129	S	5×10^{-6}	2×10^{-2}	2×10^{-7}	8×10^{-4}
			I	4×10^{-6}	2×10^{-2}	1×10^{-7}	8×10^{-4}
		Te 131m	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
			I	2×10^{-7}	1×10^{-3}	6×10^{-9}	4×10^{-5}
		Te 132	S	2×10^{-7}	9×10^{-4}	7×10^{-9}	3×10^{-5}
			I	1×10^{-7}	6×10^{-4}	4×10^{-9}	2×10^{-5}
Terbium (65)		Tb 160	S	1×10^{-7}	1×10^{-3}	3×10^{-9}	4×10^{-5}
			I	3×10^{-8}	1×10^{-3}	1×10^{-9}	4×10^{-5}
Thallium (81)		Tl 200	S	3×10^{-6}	1×10^{-2}	9×10^{-8}	4×10^{-4}
			I	1×10^{-6}	7×10^{-3}	4×10^{-8}	2×10^{-4}
		Tl 201	S	2×10^{-6}	9×10^{-3}	7×10^{-8}	3×10^{-4}
			I	9×10^{-7}	5×10^{-3}	3×10^{-8}	2×10^{-4}
		Tl 202	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
			I	2×10^{-7}	2×10^{-3}	8×10^{-9}	7×10^{-5}
		Tl 204	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
			I	3×10^{-8}	2×10^{-3}	9×10^{-10}	6×10^{-5}
Thorium (90)	*	Th 227	S	3×10^{-10}	5×10^{-4}	1×10^{-11}	2×10^{-5}
			I	2×10^{-10}	5×10^{-4}	6×10^{-12}	2×10^{-5}
		Th 228	S	9×10^{-12}	2×10^{-4}	3×10^{-13}	7×10^{-6}
			I	6×10^{-12}	4×10^{-4}	2×10^{-13}	1×10^{-5}
		Th 230	S	2×10^{-12}	5×10^{-5}	8×10^{-14}	2×10^{-6}
			I	1×10^{-11}	9×10^{-4}	3×10^{-13}	3×10^{-5}
	*	Th 231	S	1×10^{-6}	7×10^{-3}	5×10^{-8}	2×10^{-4}
			I	1×10^{-6}	7×10^{-3}	4×10^{-8}	2×10^{-4}
		Th 232	S	3×10^{-11}	5×10^{-5}	1×10^{-12}	2×10^{-6}
			I	3×10^{-11}	1×10^{-3}	1×10^{-12}	4×10^{-5}
	†*	Th natural	S	6×10^{-11}	6×10^{-5}	2×10^{-12}	2×10^{-6}
			I	6×10^{-11}	6×10^{-4}	2×10^{-12}	2×10^{-5}

APPENDIX B

Concentrations in Air and Water Above Natural Background—Continued

(See footnotes on page 20-15)

Element (atomic number)		Isotope[1]	†	Table I Column 1 Air (μCi/ml)	Table I Column 2 Water (μCi/ml)	Table II Column 1 Air (μCi/ml)	Table II Column 2 Water (μCi/ml)
Thorium (90)		Th 234	S	6×10^{-8}	5×10^{-4}	2×10^{-9}	2×10^{-5}
			I	3×10^{-8}	5×10^{-4}	1×10^{-9}	2×10^{-5}
Thulium (69)		Tm 170	S	4×10^{-8}	1×10^{-3}	1×10^{-9}	5×10^{-5}
			I	3×10^{-8}	1×10^{-3}	1×10^{-9}	5×10^{-5}
		Tm 171	S	1×10^{-7}	1×10^{-2}	4×10^{-9}	5×10^{-4}
			I	2×10^{-7}	1×10^{-2}	8×10^{-9}	5×10^{-4}
Tin (50)		Sn 113	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	9×10^{-5}
			I	5×10^{-8}	2×10^{-3}	2×10^{-9}	8×10^{-5}
		Sn 125	S	1×10^{-7}	5×10^{-4}	4×10^{-9}	2×10^{-5}
			I	8×10^{-8}	5×10^{-4}	3×10^{-9}	2×10^{-5}
Tungsten (Wolfram) (74)		W 181	S	2×10^{-6}	1×10^{-2}	8×10^{-8}	4×10^{-4}
			I	1×10^{-7}	1×10^{-2}	4×10^{-9}	3×10^{-4}
		W 185	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
			I	1×10^{-7}	3×10^{-3}	4×10^{-9}	1×10^{-4}
		W 187	S	4×10^{-7}	2×10^{-3}	2×10^{-8}	7×10^{-5}
			I	3×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
Uranium (92)		U 230	S	3×10^{-10}	1×10^{-4}	1×10^{-11}	5×10^{-6}
			I	1×10^{-10}	1×10^{-4}	4×10^{-12}	5×10^{-6}
		U 232	S	1×10^{-10}	8×10^{-4}	3×10^{-12}	3×10^{-5}
			I	3×10^{-11}	8×10^{-4}	9×10^{-13}	3×10^{-5}
		U 233	S	5×10^{-10}	9×10^{-4}	2×10^{-11}	3×10^{-5}
			I	1×10^{-10}	9×10^{-4}	4×10^{-12}	3×10^{-5}
	**	U 234	S[4]	6×10^{-10}	9×10^{-4}	2×10^{-11}	3×10^{-5}
			I	1×10^{-10}	9×10^{-4}	4×10^{-12}	3×10^{-5}
	**	U 235	S[4]	5×10^{-10}	8×10^{-4}	2×10^{-11}	3×10^{-5}
			I	1×10^{-10}	8×10^{-4}	4×10^{-12}	3×10^{-5}
		U 236	S	6×10^{-10}	1×10^{-3}	2×10^{-11}	3×10^{-5}
			I	1×10^{-10}	1×10^{-3}	4×10^{-12}	3×10^{-5}
	**	U 238	S[4]	7×10^{-11}	1×10^{-3}	3×10^{-12}	4×10^{-5}
			I	1×10^{-10}	1×10^{-3}	5×10^{-12}	4×10^{-5}
		U 240	S	2×10^{-7}	1×10^{-3}	8×10^{-9}	3×10^{-5}
			I	2×10^{-7}	1×10^{-3}	6×10^{-9}	3×10^{-5}
	**	U-natural	S[4]	1×10^{-10}	1×10^{-3}	5×10^{-12}	3×10^{-5}
			I	1×10^{-10}	1×10^{-3}	5×10^{-12}	3×10^{-5}
Vanadium (23)		V 48	S	2×10^{-7}	9×10^{-4}	6×10^{-9}	3×10^{-5}
			I	6×10^{-8}	8×10^{-4}	2×10^{-9}	3×10^{-5}
Xenon (54)		Xe 131m	Sub	2×10^{-5}	....	4×10^{-7}	....
		Xe 133	Sub	1×10^{-5}	....	3×10^{-7}	....
		Xe 133m	Sub	1×10^{-5}	....	3×10^{-7}	....
		Xe 135	Sub	4×10^{-6}	....	1×10^{-7}	....
Ytterbium (70)		Yb 175	S	7×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
			I	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
Yttrium (39)		Y 90	S	1×10^{-7}	6×10^{-4}	4×10^{-9}	2×10^{-5}
			I	1×10^{-7}	6×10^{-4}	3×10^{-9}	2×10^{-5}
		Y 91m	S	2×10^{-5}	1×10^{-1}	8×10^{-7}	3×10^{-3}
			I	2×10^{-5}	1×10^{-1}	6×10^{-7}	3×10^{-3}
		Y 91	S	4×10^{-8}	8×10^{-4}	1×10^{-9}	3×10^{-5}
			I	3×10^{-8}	8×10^{-4}	1×10^{-9}	3×10^{-5}
		Y 92	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
			I	3×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
		Y 93	S	2×10^{-7}	8×10^{-4}	6×10^{-9}	3×10^{-5}
			I	1×10^{-7}	8×10^{-4}	5×10^{-9}	3×10^{-5}

NOTE: Amendments made by 40 FR 50704 become effective 1/29/76.

25 FR 10914

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APPENDIX B

Concentrations in Air and Water Above Natural Background—Continued

(See footnotes on page 20-15)

Element (atomic number)	Isotope [1]		Table I Column 1 Air (μCi/ml)	Table I Column 2 Water (μCi/ml)	Table II Column 1 Air (μCi/ml)	Table II Column 2 Water (μCi/ml)
Zinc (30)	Zn 65	S	1×10^{-7}	3×10^{-3}	4×10^{-9}	1×10^{-4}
		I	6×10^{-8}	5×10^{-3}	2×10^{-9}	2×10^{-4}
	Zn 69m	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	7×10^{-5}
		I	3×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
	Zn 69	S	7×10^{-6}	5×10^{-2}	2×10^{-7}	2×10^{-3}
		I	9×10^{-6}	5×10^{-2}	3×10^{-7}	2×10^{-3}
Zirconium (40)	Zr 93	S	1×10^{-7}	2×10^{-2}	4×10^{-9}	8×10^{-4}
		I	3×10^{-7}	2×10^{-2}	1×10^{-8}	8×10^{-4}
	Zr 95	S	1×10^{-7}	2×10^{-3}	4×10^{-9}	6×10^{-5}
		I	3×10^{-8}	2×10^{-3}	1×10^{-9}	6×10^{-5}
	Zr 97	S	1×10^{-7}	5×10^{-4}	4×10^{-9}	2×10^{-5}
		I	9×10^{-8}	5×10^{-4}	3×10^{-9}	2×10^{-5}
Any single radionuclide not listed above with decay mode other than alpha emission or spontaneous fission and with radioactive half-life less than 2 hours.		Sub	1×10^{-6}		3×10^{-8}	
Any single radionuclide not listed above with decay mode other than alpha emission or spontaneous fission and with radioactive half-life greater than 2 hours.			3×10^{-9}	9×10^{-5}	1×10^{-10}	3×10^{-6}
Any single radionuclide not listed above, which decays by alpha emission or spontaneous fission.			6×10^{-13}	4×10^{-7}	2×10^{-14}	3×10^{-8}

25 FR 10914

[1] Soluble (S); Insoluble (I).

[2] "Sub" means that values given are for submersion in a semispherical infinite cloud of airborne material.

40 FR 50704

[3] These radon concentrations are appropriate for protection from radon-222 combined with its short-lived daughters. Alternatively, the value in Table I may be replaced by one-third (1/3) "working level." (A "working level" is defined as any combination of short-lived radon-222 daughters, polonium-218, lead-214, bismuth-214 and polonium-214, in one liter of air, without regard to the degree of equilibrium, that will result in the ultimate emission of 1.3 x 10^5 MeV of alpha particle energy.) The Table II value may be replaced by one-thirtieth (1/30) of a "working level." The limit on radon-222 concentrations in restricted areas may be based on an annual average.

39 FR 23990

‡4. For soluble mixtures of U-238, U-234 and U-235 in air chemical toxicity may be the limiting factor. If the percent by weight (enrichment) of U-235 is less than 5, the concentration value for a 40-hour workweek, Table I, is 0.2 milligrams uranium per cubic meter of air average. For any enrichment, the product of the average concentration and time of exposure during a 40-hour workweek shall not exceed 8×10^{-5} SA μCi-hr/ml, where SA is the specific activity of the uranium inhaled. The concentration value for Table II is 0.007 milligrams uranium per cubic meter of air. The specific activity for natural uranium is 6.77×10^{-7} curies per gram U. The specific activity for other mixtures of U-238, U-235 and U-234, if not known, shall be:

$SA=3.6\times10^{-7}$ curies/gram U   U-depleted

$SA=(0.4+0.38E+0.0034E^2)\ 10^{-6}$ $E\geq0.72$

where E is the percentage by weight of U-235, expressed as percent.

*Amended 37 FR 23319.

**Amended 39 FR 23990; footnote redesignated 40 FR 50704.

***Amended 40 FR 50704.

†Amended 38 FR 29314.

‡Amended 39 FR 25463; redesignated 40 FR 50704.

NOTE: Amendments made by 40 FR 50704 become effective 1/29/76.

NOTE TO APPENDIX B

25 FR 10914

NOTE: In any case where there is a mixture in air or water of more than one radionuclide, the limiting values for purposes of this Appendix should be determined as follows:

1. If the identity and concentration of each radionuclide in the mixture are known, the limiting values should be derived as follows: Determine, for each radionuclide in the mixture, the ratio between the quantity present in the mixture and the limit otherwise established in Appendix B for the specific radionuclide when not in a mixture. The sum of such ratios for all the radionuclides in the mixture may not exceed "1" (i.e., "unity").

EXAMPLE: If radionuclides A, B, and C are present in concentrations C_A, C_B, and C_C, and if the applicable MPC's, are MPC_A, and MPC_B, and MPC_C respectively, then the concentrations shall be limited so that the following relationship exists:

$$\frac{C_A}{MPC_A}+\frac{C_B}{MPC_B}+\frac{C_C}{MPC_C}\leq 1$$

30 FR 15801

2. If either the identity or the concentration of any radionuclide in the mixture is not known, the limiting values for purposes of Appendix B shall be:

a. For purposes of Table I, Col. 1—6×10^{-13}
b. For purposes of Table I, Col. 2—4×10^{-7}
c. For purposes of Table II, Col. 1—2×10^{-14}
d. For purposes of Table II, Col. 2—3×10^{-8}

26 FR 11046

3. If any of the conditions specified below are met, the corresponding values specified below may be used in lieu of those specified in paragraph 2 above.

a. If the identity of each radionuclide in the mixture is known but the concentration of one or more of the radionuclides in the mixture is not known, the concentration limit for the mixture is the limit specified in Appendix "B" for the radionuclide in the mixture having the lowest concentration limit; or

b. If the identity of each radionuclide in the mixture is not known, but it is known that certain radionuclides specified in Appendix "B" are not present in the mixture, the concentration limit for the mixture is the lowest concentration limit specified in Appendix "B" for any radionuclide which is not known to be absent from the mixture; or

30 FR 15801

c. Element (atomic number) and isotope	Table I Column 1 Air (μCi/ml)	Table I Column 2 Water (μCi/ml)	Table II Column 1 Air (μCi/ml)	Table II Column 2 Water (μCi/ml)
If it is known that Sr 90, I 125, I 126, I 129, I 131, (I 133, table II only), Pb 210, Po 210, At 211, Ra 223, Ra 224, Ra 226, Ac 227, Ra 228, Th 230, Pa 231, Th 232, Th-nat, Cm 248, Cf 254, and Fm 256 are not present	----------	9×10^{-5}	----------	3×10^{-6}
If it is known that Sr 90, I 125, I 126, I 129, (I 131, I 133, table II only), Pb 210, Po 210, Ra 223, Ra 226, Ra 228, Pa 231, Th-nat, Cm 248, Cf 254, and Fm 256 are not present	----------	6×10^{-5}	----------	2×10^{-6}
If it is known that Sr 90, I 129, (I 125, I 126, I 131, table II only), Pb 210, Ra 226, Ra 228, Cm 248, and Cf 254 are not present	----------	2×10^{-5}	----------	6×10^{-7}
If it is known that (I 129, table II only), Ra 226, and Ra 228 are not present	----------	3×10^{-6}	----------	1×10^{-7}
If it is known that alpha-emitters and Sr 90, I 129, Pb 210, Ac 227, Ra 228, Pa 230, Pu 241, and Bk 249 are not present	3×10^{-9}	----------	1×10^{-10}	----------
If it is known that alpha-emitters and Pb 210, Ac 227, Ra 228, and Pu 241 are not present	3×10^{-10}	----------	1×10^{-11}	----------
If it is known that alpha-emitters and Ac 227 are not present	3×10^{-11}	----------	1×10^{-12}	----------
If it is known that Ac 227, Th 230, Pa 231, Pu 238, Pu 239, Pu 240, Pu 242, Pu 244, Cm 248, Cf 249 and Cf 251 are not present	3×10^{-12}	----------	1×10^{-13}	----------

40 FR 50704

4. If a mixture of radionuclides consists of uranium and its daughters in ore dust prior to chemical separation of the uranium from the ore, the values specified below may be used for uranium and its daughters through radium-226, instead of those from paragraphs 1, 2, or 3 above.

39 FR 23990

a. For purposes of Table I, Col. 1—1×10^{-10} μCi/ml gross alpha activity; or 5×10^{-11} μCi/ml natural uranium; or 75 micrograms per cubic meter of air natural uranium.

b. For purposes of Table II, Col. 1—3×10^{-12} μCi/ml gross alpha activity; or 2×10^{-12} μCi/ml natural uranium; or 3 micrograms per cubic meter of air natural uranium.

26 FR 11046

5. For purposes of this note, a radionuclide may be considered as not present in a mixture if (a) the ratio of the concentration of that radionuclide in the mixture (C_A) to the concentration limit for that radionuclide specified in Table II of Appendix B (MPC_A) does not exceed 1/10 (i.e. $\frac{C_A}{MPC_A}\leq\frac{1}{10}$) and (b) the sum of such ratios for all the radionuclides considered as not present in the mixture does not exceed ¼ (i.e. $\frac{C_A}{MPC_A}+\frac{C_B}{MPC_B}+\ldots\ldots\leq ¼$).

NOTE: Amendments made by 40 FR 50704 become effective 1/29/76.

APPENDIX C

Material	Microcuries
Americium-241	.01
Antimony-122	100
Antimony-124	10
Antimony-125	10
Arsenic-73	100
Arsenic-74	10
Arsenic-76	10
Arsenic-77	100
Barium-131	10
*Barium-133	10
Barium-140	10
Bismuth-210	1
Bromine-82	10
Cadmium-109	10
Cadmium-115m	10
Cadmium-115	100
Calcium-45	10
Calcium-47	10
Carbon-14	100
Cerium-141	100
Cerium-143	100
Cerium-144	1
Cesium-131	1,000
Cesium-134m	100
Cesium-134	1
Cesium-135	10
Cesium-136	10
Cesium-137	10
Chlorine-36	10
Chlorine-38	10
Chromium-51	1,000
Cobalt-58m	10
Cobalt-58	10
Cobalt-60	1
Copper-64	100
Dysprosium-165	10
Dysprosium-166	100
Erbium-169	100
Erbium-171	100
Europium-152 9.2 h	100
Europium-152 13 yr	1
Europium-154	1
Europium-155	10
Fluorine-18	1,000
Gadolinium-153	10
Gadolinium-159	100
Gallium-72	10
Germanium-71	100
Gold-198	100
Gold-199	100
Hafnium-181	10
Holmium-166	100
Hydrogen-3	1,000
Indium-113m	100
Indium-114m	10
Indium-115m	100
Indium-115	10
Iodine-125	1
Iodine-126	1
Iodine-129	0.1
Iodine-131	1
Iodine-132	10
Iodine-133	1
Iodine-134	10
Iodine-135	10
Iridium-192	10
Iridium-194	100
Iron-55	100
Iron-59	10
Krypton-85	100
Krypton-87	10
Lanthanum-140	10
Lutetium-177	100
Manganese-52	10
Manganese-54	10
Manganese-56	10
Mercury-197m	100
Mercury-197	100
Mercury-203	10
Molybdenum-99	100
Neodymium-147	100
Neodymium-149	100
Nickel-59	100
Nickel-63	10
Nickel-65	100
Niobium-93m	10
Niobium-95	10
Niobium-97	10
Osmium-185	10
Osmium-191m*	100
Osmium-191	100
Osmium-193	100
Palladium-103	100
Palladium-109	100
Phosphorus-32	10
Platinum-191	100
Platinum-193m	100
Platinum-193	100
Platinum-197m	100
Platinum-197	100
Plutonium-239	.01
Polonium-210	0.1
Potassium-42	10
Praseodymium-142	100
Praseodymium-143	100
Promethium-147	10
Promethium-149	10
Radium-226	.01
Rhenium-186	100
Rhenium-188	100
Rhodium-103m	100
Rhodium-105	100
Rubidium-86	10
Rubidium-87	10
Ruthenium-97	100
Ruthenium-103	10
Ruthenium-105	10
Ruthenium-106	1
Samarium-151	10
Samarium-153	100
Scandium-46	10
Scandium-47	100
Scandium-48	10
Selenium-75	10
Silicon-31	100
Silver-105	10
Silver-110m	1
Silver-111	100
Sodium-24	10
Strontium-85	10
Strontium-89	1
Strontium-90	0.1
Strontium-91	10
Strontium-92	10
Sulphur-35	100
Tantalum-182	10
Technetium-96	10
Technetium-97m	100
Technetium-97	100
Technetium-99m	100
Technetium-99	10
Tellurium-125m	10
Tellurium-127m	10
Tellurium-127	100
Tellurium-129m	10
Tellurium-129	100
Tellurium-131m	10
Tellurium-132	10
Terbium-160	10
Thallium-200	100
Thallium-201	100
Thallium-202	100
Thallium-204	10
**Thorium (natural)[1]	100
Thulium-170	10
Thulium-171	10
Tin-113	10
Tin-125	10
Tungsten-181	10
Tungsten-185	10
Tungsten-187	100
**Uranium (natural)[2]	100
Uranium-233	.01
Uranium-234—Uranium-235	.01
Vanadium-48	10
Xenon-131m	1,000
Xenon-133	100
Xenon-135	100
Ytterbium-175	100
Yttrium-90	10
Yttrium-91	10
Yttrium-92	100
Yttrium-93	100
Zinc-65	10
Zinc-69m	100
Zinc-69	1,000
Zirconium-93	10
Zirconium-95	10
Zirconium-97	10
Any alpha emitting radionuclide not listed above or mixtures of alpha emitters of unknown composition	.01
Any radionuclide other than alpha emitting radionuclides, not listed above or mixtures of beta emitters of unknown composition	.1

NOTE: For purposes of §§ 20.203 and 20.304, where there is involved a combination of isotopes in known amounts the limit for the combination should be derived as follows: Determine, for each isotope in the combination, the ratio between the quantity present in the combination and the limit otherwise established for the specific isotope when not in combination. The sum of such ratios for all the isotopes in the combination may not exceed "1" (i.e., "unity"). Example: For purposes of § 20.304, if a particular batch contains 20,000 μCi† of Au^{198} and 50,000 μCi† of C^{14}, it may also include not more than 300 μCi† of I^{131}. This limit was determined as follows:

$$\dagger\ \frac{20{,}000\ \mu Ci\ Au^{198}}{100{,}000\ \mu Ci} + \frac{50{,}000\ \mu Ci\ C^{14}}{100{,}000\ \mu Ci} + \frac{300\ \mu Ci\ I^{131}}{1{,}000\ \mu Ci} = 1$$

The denominator in each of the above ratios was obtained by multiplying the figure in the table by 1,000 as provided in § 20.304.

35 FR 6425

[1] Based on alpha disintegration rate of Th-232, Th-230 and their daughter products.

[2] Based on alpha disintegration rate of U-238, U-234, and U-235.

* Amended 36 FR 16898.

** Amended 39 FR 23990.

† Amended 38 FR 29314.

Appendix D

UNITED STATES NUCLEAR REGULATORY COMMISSION

INSPECTION AND ENFORCEMENT REGIONAL OFFICES

Region	Address	Telephone	
		Daytime	Nights and Holidays
I Connecticut, Delaware, District of Columbia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont	Region I, USNRC Office of Inspection and Enforcement 631 Park Avenue King of Prussia, Pa. 19406	(215) 337-1150	(215) 337-1150
II* Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, Panama Canal Zone, Puerto Rico, South Carolina, Tennessee, Virginia, Virgin Islands, and West Virginia	Region II, USNRC Office of Inspection and Enforcement 230 Peachtree St., N.W. Suite 818 Atlanta, Ga. 30303	(404) 526-4503	(404) 526-4503
III Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Ohio, and Wisconsin	Region III, USNRC Office of Inspection and Enforcement 799 Roosevelt Road Glen Ellyn, Ill. 60137	(312) 858-2660	(312) 858-2660
IV* Arkansas, Colorado, Idaho, Kansas, Louisiana, Montana, Nebraska, New Mexico, North Dakota, Oklahoma, South Dakota, Texas, Utah, and Wyoming	Region IV, USNRC Office of Inspection and Enforcement 611 Ryan Plaza Drive Suite 1000 Arlington, Texas 76012	(817) 334-2841	(817) 334-2841
V Alaska, Arizona, California, Hawaii, Nevada, Oregon, Washington, and U.S. territories and possessions in the Pacific	Region V, USNRC Office of Inspection and Enforcement 1990 N. California Blvd. Suite 202 Walnut Creek, Calif. 94596	(415) 486-3141	(415) 486-3141

40 FR 42557

NOTE: The reporting and record keeping requirements contained in §§20.205(b) and 20.205(c) and required by §20.401(b) have been approved by GAO under B-180225 (R0054). The approval expires June 30, 1977.